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Do algorithms provide consistency in clinical cue acquisition in telephone consultation at NHS direct?

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DO ALGORITHMS PROVIDE CONSISTENCY IN CLINICAL CUE ACQUISITION IN TELEPHONE CONSULTATION AT NHS DIRECT?

by

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Abstract

Background

A number of studies have concluded that significant variation exists in nurse decision-making when using Clinical Decision Support Systems (CDSS) in the telephone consultation setting. This is surprising, since one of the major purported benefits of using CDSS is enhanced consistency and safety. It is thought that algorithm based CDSS reduces decision-making variance by providing a template of specimen questions to capture all relevant cues during a consultation. This study was undertaken to determine if a) the use of specimen questions and clinical cue acquisition does not differ significantly between two key independent variables when using an algorithm based CDSS (call centre and algorithm) and b) to determine whether there was any correlation between clinical cue acquisition and the consultation outcome (disposition). Two of the most frequently used algorithms at NHS Direct were chosen for the study; an adult specific presentation (Abdominal Pain) and a child specific presentation (Fever Toddler). The settings were two call centres at NHS Direct, the health advice and health information service delivering telephone consultation to the general public throughout England and Wales.

Methods

The audio recordings of 250 NHS Direct nurse consultations were examined and coded. The two algorithms chosen for the study were frequently used at NHS Direct and also provided the opportunity to compare two different consultation types; a direct interlocution with the patient (Abdominal Pain) and a third party interlocution with the patient's parent or carer (Fever Toddler). Difference tests were conducted to determine variance in clinical cue acquisition and a correlation test was carried out to determine the relationship of clinical cue acquisition with the disposition.

Results

The frequency of clinical cue negative specimen questions (CCA-) differed by algorithm, (U=5314, Z=-4.457, p=<0.001).

A significant correlation between CCA- specimen questions and the disposition (r= 0.230, p=<0.001). Between 1 and 11 specimen questions were CCA- in 70% (175/250) consultations. Across the 250 consultations, 6,501 specimen questions were available to Nurse Advisors using the NHS Clinical Assessment System, 91.66% (5,559/6,501) of specimen questions were CCA+, 8.34% (542/6,501) were CCA-.

Conclusion

Significant variance exists in the use of specimen questions in consultations at NHS Direct. This variance is apparent despite the use of an algorithm based CDSS which is designed to reduce variance in assessments and decision-making. Furthermore, clinical cue acquisition is related to the consultation outcome raising questions concerning the clinical safety in consultations that have a high frequency CCA- specimen questions. However, the within methods quantitative methodology of the study has limitations and further across methods research is required to fully explain the variance in the acquisition of clinical cues supported by an algorithm based CDSS.

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1. Rationale for Study

From the inception of the service in 1998, NHS Direct has striven for a standardised approach to clinical telephone consultations. By moving from separately governed call centres hosted by various NHS Trusts to become a single national organisation; firstly as a Special Health Authority and latterly as an NHS Trust; NHS Direct has the national infrastructure to facilitate standardised care. A single prioritisation system and the development of the virtual contact centre has further facilitated a homogenous approach and one of the central reasons for procuring an algorithm or protocol based national CDSS was the supposition that algorithms would bring consistency to judgement and decision-making at NHS Direct. However, in studies focused on algorithm based software it appears that that algorithms may not have delivered a standardised approach to clinical decision-making [Farrand et al. (1995), Wachter (1999), Garg et al. (2005), Mayo (2002), Purcell (2005), Kong et al., (2008), Dowding et al. (2009)]. Further details of CDSS studies are described in sections 1.2.1 (p.2). For NHS Direct specific studies, the same findings have emerged; the CDSS used, whether it was NHS CAS or previous software systems, have not delivered a consistency in the use of the CDSS, or the outcomes it assists [Munro et al. (2000, 2001, 2005), Grant et al. (2002), O'Cathain et al. (2007), Monoghan et al. (2003), Lambell et al. (2003), Richards (2004) and Rustan (2006)]. Further details of NHS Direct studies are described in sections 1.2.2 (p.4). One key factor that could potentially contribute to variance in decision-making is the comprehensiveness of clinical cue acquisition. If clinical cue acquisition was significantly different across consultations by some key independent variables (call centre or algorithm), then decision-making itself could vary as Nurse Advisors would form judgements based on information that varied even when the clinical presentation was similar. This hypothesis would be strengthened if there was a correlation between clinical cue acquisition and the disposition. The NHS Direct studies to date have determined a level of inconsistency in decision-making and have postulated some reasons why this may occur. This study examines a specific variable (clinical cue acquisition) that may be an explanatory factor in inconsistencies in decision-making with an algorithm based CDSS (NHS CAS). Therefore the focus of this study is a specific area of research, which hitherto has not been explored systematically and builds on previous research in this field.

If this study determines that significant difference is present in clinical cue acquisition at NHS Direct, this could prove to be an important predictor of decision-making variance.

1.2 Research in this field

1.2.1 Evidence and reviews of CDSS in healthcare

In a large systematic review of the clinical impact of CDSS's (Garg, Nicholas, Moore and Salisbury, 2005), found that 41 CDSS's demonstrated an improvement in clinician performance while 24 delivered no improvement. However, improvements in clinician performance did not appear to translate into benefits for the patient. None of the 65 CDSS's demonstrated any beneficial effect on patient outcomes. Where CDSS's performed poorly the main factors were poor usability, poor integration into the clinician's daily workflow and non-compliance with CDSS recommendations. However, the size and scope of this analysis may have been too broad to draw any conclusions applicable to specific settings. 100 clinical trials met the criteria for the study which included a variety of CDSS's used by a wide range of clinicians, some at academic centres, some involving inpatients, some CDSS's prompted the clinician with a conclusion or advice, others didn't, there was a disparate range of graphical user interfaces and methods of input and information retrieval were also varied. An important limitation cited within the study stated;

> *'...we defined improvement as a positive effect on at least 50% of outcomes measured. This approach, along with the strict inclusion criteria of this review, may have underestimated the influence of some system and study methodological factors on CDSS success.'* (Garg, Nicholas, Moore and Salisbury, 2005, p.1235).

Also, the confidence intervals for determining CDSS success across the many categories in the study were large; raising concerns over the reliability of the results. Therefore this study is probably most beneficial in helping to frame the questions in this field of research rather than providing cogent answers. Purcell (2005) commented on the difficulties of constructing and maintaining the knowledge base that underpins CDSS's, in the context of rapidly changing medical knowledge. In a literature review, (Kong, XU and Bo-Yang, 2008) proposed that the literature demonstrated the need for a CDSS to fulfil 4 basic criteria;

> *...a CDSS should have a clinical domain knowledge base which has been validated in practice, an intelligent diagnostic inference mechanism which can handle medical uncertainties, and accurate diagnostic or therapeutic recommendations and a friendly user interface that can be easily accepted and used by clinicians.* (Kong, XU and Bo-Yang, 2008, p.165)

This overarching criterion provides a useful framework for benchmarking CDSS's. However, the focus in this study was on CDSS's that use mathematical processes to generate a recommendation to the user. A number of CDSS's do not utilise this methodology, such as the NHS Direct CDSS; NHS CAS.

Several studies have demonstrated significant variation in the use of the same CDSS and the outcomes generated. Wachter, Brillman, Lewis and Sapien, (1999) found significant variation in the use of a protocol based system by nurses in a simulation study. 12 paediatric emergency care nurses we presented with 15 mock respiratory scenarios, the consultation was conducted using an algorithm based CDSS. The study confirmed substantial variation in the choice of algorithm by nurses faced with the same presentation and also demonstrated poor concordance in the final advice given. The conclusion drawn was that algorithms do not necessarily assure a standardised approach to assessment and decision-making. This was a relatively small study, with a narrow scope of 12 nurses from the same department and included only respiratory scenarios. It is possible that some element of the department's operational management may have contributed to variable assessment and decision-making; for example, low provision and uptake of continued professional development. Also, only one CDSS was used, so careful consideration of the algorithms used would be necessary in order to generalise any conclusions. Dowding, et al. (2009) found that nurses vary in how they use CDSS's, This study included 115 observations of nurse consultations which were assisted by various CDSS's in four different clinical environments, along with 55 nurse interviews. The conclusion drawn from thematic analysis was that nurse experience and the propensity of the nurse to override the CDSS recommended disposition were the two key variances in use of a CDSS. The study also ventured that routine overriding of CDSS recommendations undermined the central precept of implementing CDSS's; namely, improving the consistency of assessing and advising the patient. Clearly it is possible that the nurse could override the recommended disposition, but arrive at a more appropriate disposition by gathering visual or verbal cues that the particular CDSS was not designed to gather or process. Therefore this conclusion is challengeable since it assumes that recommendation compliant dispositions are less error free than recommendation divergent dispositions. The study did not establish this premise and it is noteworthy that not all studies agree that overriding or variance is inherently undesirable when using a CDSS.

1.2.2 Research and Evaluations of NHS Direct

Previous studies of NHS Direct have broadly fallen into three categories:

1. Impact of the service on the NHS healthcare system or economy.
2. Appropriateness of NHS Direct dispositions.
3. Variance in NHS Direct decision-making

Impact

The impact of the NHS Direct service rests largely upon guiding callers from the general public to the most appropriate part of the health system or alternatively, giving appropriate 'self care' advice. A pre-dependency of this achievement is appropriate decision-making from NHS Direct Nurse Advisors and this study examines a potential pre-dependency of appropriate decision-making (clinical cue acquisition). It is therefore relevant to consider research into the impact NHS Direct has made within healthcare in order to frame what part clinical cue acquisition may have played and continue to play in achieving the services primary objectives. Much of the focus and attention of studies conducted to date has fallen on the impact of NHS Direct on access to health care. A phased study of the NHS Direct First Wave sites was commissioned by the Department of Health, and conducted by the Medical Care Research Unit, University of Sheffield. An interim report of the first year of the NHS Direct service (Munro, Nicholl, O'Cathain and Knowles, 2000) demonstrated that that there had been no significant impact in utilisation of ambulance and Accident and Emergency services. However, there was a small but significant change in trends for GP Co-operatives in the areas served by NHS Direct at that point. The study compared areas that were covered by the NHS Direct service with 6 control areas (GP Co-Operatives – 'Out of Hours' service) that were not at the time served by NHS Direct. The patient activity (demand upon the services) were analysed for differences before and after the introduction of the NHS Direct service. In the GP Co-operative areas there had been no significant change in demand for 'Out of Hours' (OOH) services, whereas in the areas where the NHS Direct service had been implemented there had been a reduction of 2.9% for 'OOH' services. This suggested that in the three areas where the NHS Direct service had been implemented, some demand had been diverted away from 'OOH' to services providing less urgent care; since as stated above there had been no significant impact on emergency services. This was a large study which analysed 65,500 calls to NHS Direct. However, the study focused on the 12 month period before the implementation of NHS Direct and the 12 months afterwards. It is unlikely that the NHS Direct service would be able to maximise its

impact during an implementation period. Also, the 6 control areas were chosen for their proximity to the NHS Direct areas, rather than matching demographic characteristics such as, deprivation, ethnicity and age. A demographic match of comparator areas, rather than using contiguous geographic areas may have provided greater assurance of reliability and validity by controlling for the important demographic variables. Furthermore, each local health economy in the study would have some elements of service provision that differed from other localities and differences in access to healthcare across the localities included in the study were not considered in this research.

However, in a later study (Munro, Sampson and Nicholl, 2005) reported that in the first three years of the NHS Direct service it had reduced demand to 'OOH' services; a yearly 8% decrease in volumes. Once again, the effect on demand for Accident and Emergency departments remained non- significant. This was a larger study than the previous one in which information was requested from all GP Co-operatives, ambulance services and emergency departments in England and Wales. Although the response rates were high overall, 37% of GP Co-operatives did not return figures and some of those that did, returned incomplete data sets. Therefore although the study was much larger than the previous one, the impact of omissions in the data would be important to evaluate its overall merit. If the GP Co-operatives that did not supply data were randomly distributed across urban and rural demographics then the impact of the missing data would be reduced. However, if this was not the case then confounding demographic variables could potentially be present.

The conclusions regarding the impact of NHS Direct in the first interim report (Munro, Nicholl, O'Cathain and Knowles, 2000) attracted attention and stimulated a number of smaller studies in response. In a survey of 300 consecutive patients that self referred to the Accident and Emergency department at Leicester Royal Infirmary (McInereny, Chillala, Read and Evans, 2000) found that awareness of the NHS Direct service was low, with 62% of patients having no previous awareness of NHS Direct. The survey also contained demographic information which suggested that awareness and understanding of NHS Direct was low among the population who most frequently access urgent health care. Therefore, it was concluded that the impact of NHS Direct, especially in the area of reducing demand on the emergency and urgent health care services was being impeded by lack of public awareness. However, this study was small scale and by choosing consecutive patients, peculiarities of the time frame may have distorted results. Nonetheless, this study highlights another variable other than Nurse Advisor decision-making that could influence the impact of the service.

In Research undertaken in the North West of England, (Stewart, Fairhurst, Markland and

Marzouk, 2006) reported that referrals from NHS Direct to the paediatric accident and emergency department at the Royal Liverpool Children's NHS Trust, Alder Hey, represented only a small proportion of the attendances there (3.2%). Furthermore, nearly one third of these had been given different advice than to attend A&E by NHS Direct but had decided to attend nonetheless. Also, 15% of all children referred to Alder Hey emergency department by NHS Direct were admitted during the three month study period. This combined with another of the study findings; "A significantly higher proportion of patients in the NHS-D group were discharged compared with either patients referred by the general practitioner or self-referred patients" (Stewart, Stewart, Fairhurst, Markland and Marzouk, 2006, p.914), suggests that the appropriateness of referrals from NHS Direct was less accurate than parents and carers.

A positive impact for the NHS workforce was reported by Morrell (2002) who stated that NHS Direct has provided some nurses with employment who found it difficult to continue their nursing career elsewhere due to a disability. A number of disabilities that might preclude face to face nursing care would not apply in a call centre setting and therefore NHS Direct was reclaiming a small element of the NHS workforce that was previously lost to the profession. This research conducted a postal survey of Nurse Advisors in the 17 NHS Direct call centre's in 2000. The response rate was 74% and the study concluded that any adverse impact on broader NHS nurse staffing was likely to be minimal, although it was also noted that NHS Direct recruited experienced and well qualified nursing staff.

Appropriateness

There are few studies to date which have systematically attempted to assess the appropriateness of NHS Direct decision-making and advice. This is perhaps surprising given the attention to the impact of NHS Direct, since a key component of assessing impact must surely be the appropriateness of advice. However, appropriateness of NHS Direct Advice was addressed by the more expansive final report published by the University of Sheffield (Munro, et al., 2001), which focused on the following areas.

- Activity of First Wave NHS Direct sites
- Clinical Assessment; Methodological Issues
- Compliance with Advice given by NHS Direct
- Critical Event Monitoring
- The Economics of NHS Direct
- NHS Direct in Principle, Practice and Progress: Views of Stakeholders

The report also documented the appropriateness of advice given by NHS Direct assessed by an expert panel of 4 independent raters. However there was considerable disagreement

between raters on the most appropriate outcome and the authors recognised the considerable difficulties of drawing conclusions from this section. A definitive study on the appropriateness of NHS Direct advice has remained notably absent, despite the service being in operation for more than 10 years.

Decision-Making

O'Cathain, et al. (2003) demonstrated very substantial differences in consultation outcomes between nurses using different decision support software systems. This part of the study used 119 constructed scenarios based on minor presentations to three ambulance services. The study also included an early version of the NHS Clinical Assessment System (NHS CAS) which was to become the single clinical decision support software for NHS Direct in the future. The Accident and Emergency dispositions varied between 22% to 44% and Self Care proportions varied between 9% and 29%. Table 1 below show disposition proportions by CDSS.

Table 1: *NHS Direct Dispositions by CDSS used.*

	TAS		Personal Health Adviser		Centramax		NHS Clinical Assessment System	
Advice	n	(%)	n	(%)	n	(%)	n	(%)
Emergency ambulance	32	(26.9)	33	(27.7)	37	(31.1)	25	(21.0)
A&E department	50	(42.0)	26	(21.8)	53	(44.5)	31	(26.1)
GP immediately	6	(5.0)	25	(21.0)	9	(7.6)	18	(15.1)
GP later/other professional	9	(7.6)	16	(13.4)	9	(7.6)	11	(9.2)
Self care	22	(18.5)	19	(16.0)	11	(9.2)	34	(28.6)

*The pattern of outcomes for NHS Direct triaged calls is 2%–3% to 999 ambulance, 15%–27% to A&E, 35%–49% to general practice and 33%–35% to self care.[15]

Emergency Medical Journal, 2003. O'Cathain et al., p.290.

Scenarios delivered to nurses using the NHS CAS system delivered a lower proportion of 999 outcomes and a greater proportion of Self Care advice. The study noted that;

> *'The variation we have observed is clearly not attributable to case mix, which was held constant. If the variation is mainly attributable to the nurse, then NHS Direct callers may expect quite different advice depending on who answers their call, raising a question about the experience and training needed by nurses to enable them to answer calls appropriately. If the variation is primarily attributable to the software, then standardizing on a*

single system will obviously eliminate this'. (O'Cathain et al., 2003, p.291)

This study also reported the sensitivity and specificity of dispositions, showing that consultations which were undertaken with the support of NHS CAS had the lowest level of sensitivity of all CDSS's used by the service at the time. Table 2 below, shows the sensitivity and specificity of dispositions by CDSS used.

Table 2: *NHS Direct Dispositions by CDSS (sensitivity and specificity).*

	TAS	Personal Health Adviser	Centramax	NHS Clinical Assessment System
Sensitivity	70	51	78	49
Specificity	33	52	33	59

Emergency Medical Journal, 2003. O'Cathain et al., p.290.

The study used 119 constructed scenarios based on actual calls to ambulance services which had been categorized as low priority. Although this provided a range of scenarios, it is likely that the case mix of calls to ambulance services compared to calls taken by the NHS Direct service are different. This doesn't undermine the validity of the study since all CDSS systems and Nurse Advisors were tested in the same way, but may raise concerns about the reliability of the results, since a different case mix of calls could affect the resultant disposition profiles. The sensitivity and specificity results are presented in terms of CDSS performance, when more accurately, sensitivity and specificity is a combination of CDSS and Nurse Advisor performance. Some measures were taken to reduce the impact of Nurse Advisor variability such as including only Nurse Advisors that had been using the respective CDSS for a minimum of 3 months. However, it is still not clear from the study, which factor is contributing most to the variability of sensitivity and specificity; the CDSS's or Nurse Advisors.

A comparatively high variability in NHS Direct outcomes was noted (Grant, Nicholas, Moore and Salisbury, 2002) in standardized role play scenarios when compared to Walk in Centre's and General Practice, suggesting that decision-making variability was unusually high in consultations at NHS Direct. The study conducted 99 role play assessments to each setting (NHS Direct, GP Practices and Walk in Centres) using 5 scenarios. However, the study did not consider the different decision-making environments of telephone based

consultation and face to face assessment. In face to face assessments visual clinical cues are available but entirely absent in a telephone consultation. Therefore although demonstrable efforts had been made to standardize scenario information across the settings, telephone assessment of symptoms will always lack the visual cues a face to face assessment can utilize. Richards (2004) conducted a cluster randomised controlled trial comparing triage at NHS Direct with Practice based Nurses and found that triage outcomes were different between the two. However, the practice based nurses generally knew the patients that were involved in the trial and in many cases had seen or even treated them at the surgery previously. This patient background information was not available to NHS Direct nurses. Also the practice nurses did not use a CDSS. Furthermore, the trial focused on the differing costs of NHS Direct and practice based nurse triage and did not advance any detailed reasons for variance in decision-making.

A study analysing variance in call length and disposition (Monoghan, Clifford, McDonald, 2003) between Registered Nurses (RN's) and Registered Sick Children's Nurses (RSCN's) at NHS Direct was conducted focusing on consultations about children. The study involved the analysis of 1,281 calls to the Dudley call centre. Call length and disposition differed significantly by the nurse qualifications studied; the data had been collected when Plain Software's TAS was the CDSS in use at NHS Direct. Call length measurement was limited by the fact that the data extraction tool used, aggregated times to the nearest minute. The following year, another study supported these findings by confirming variation in NHS Direct outcome by RN and RSCN groups (Lambell, et al., 2003). This later study replicated the methodology of the (Monoghan, Clifford, McDonald, 2003) study but on this occasion the CDSS was NHS CAS, presenting the possibility that this finding may be generalisable across different types of CDSS. However, both studies included small numbers of paediatric trained Nurse Advisors, 5 or less whereas the General trained Nurse Advisor group was more than 4 times this size. Such differences in group sizes may have affected the validity of the difference test used. Although a Mann Whitney U test was performed thereby guarding against some distribution abnormalities (since non-parametric tests do not require the assumption of distribution normality), very unequal group sizes can undermine the validity of a non-parametric test. Although non-parametric tests may accommodate unequal group sizes this assertion is undermined if the groups also have homogeneity of variance, since a Mann Whitney U test is designed to establish if the mean ranks of two groups differ in location when the group variances are broadly similar. A Levene's test for homogeneity of variance would have determined if this was a problem or not and would have provided assurance that the results were valid and reliable.

Rustan, (2006) studied clinical decision-making at NHS Direct from the perspective of the potential constraints that a rule based, monitored and standardised environment may have on nurse judgement. This study focused on NHS CAS which by this point was the single CDSS in use at all NHS Direct call centres. The study demonstrated that despite the protocol driven CDSS, together with the monitoring and performance management of clinical sorting by individual nurse; widespread variance occurred in professional judgement and the identification and management of risk.

O'Cathain et al. (2007) conducted a study at NHS 24, a similar telephone assessment service to NHS Direct but operating throughout Scotland and accountable to the Scottish Parliament. Nurses were asked to risk assess 'Self Care' dispositions; dispositions where the caller was not advised to see a clinician for assessment but instead, given advice on how to manage the symptoms at home. Data was collected via a survey with responses then matched to nurse decision-making performance in managing live calls to the service. The study suggested that attitude to risk varied significantly between nurses although there was no convincing evidence that these differences affected decision-making. However, matching responses from a survey, where the nurse has considerable time to think through their reply; to a live telephone consultation, where the nurse is processing information and making decisions often against the backdrop of operational pressures, is problematic. In response to the survey questions, nurses may have been influenced by notions of professional expectation regarding risk assessment, which could have led them to provide responses that were divergent from actual practice.

1.2.3 Conclusions from research

The research to date on NHS Direct illustrates that there are a number of factors associated with the impact of the service. Appropriateness and consistency of dispositions may well be a factor that could assist the service to direct callers to the most appropriate parts of the healthcare system in a safe and timely fashion. Clinical cue acquisition may have its part to play in securing appropriateness of dispositions on a consistent basis since it is reasonable to assume that consistently appropriate dispositions must rest on consistent and comprehensive information gathering in the consultation.

The evidence shows that the use of CDSS's in healthcare have generally not generated tangible patient benefits, nor have algorithm based support systems delivered clear improvements in consistency of assessment or decision-making. Some explanatory reasons have been postulated such a variance in nurse experience and variance in risk assessment of decisions. It is important to explore the reasons why the theoretical benefits of CDSS have not been realised in practice. None of the research to date has focused specifically on clinical cue acquisition using an algorithm based CDSS, which could be an important variable that has hitherto, not been explored.

1.3 Background

1.3.1 NHS Direct

In 1997 the white paper 'A New NHS, Modern - Dependable' introduced a new service; NHS Direct (Department of Health,1997). The white paper emphasized the objective of providing a nurse led health advice and information service to the public, 24 hours a day, every day of the year. One of the key anticipated impacts was that the service would reduce demand on other NHS services by enabling greater numbers of the general public to manage non-urgent health problems at home. It was also anticipated that the service would enhance appropriate access to the right part of the health service at the right time.

NHS Direct was launched in March 1998 in three geographical areas: operated by Lancashire Ambulance Service NHS Trust, Northumbria Ambulance Service NHS Trust and Two Shires Ambulance Service NHS Trust (NHS Direct, 2009) serving a population of 1.3 million people. Telephone consultations were supported by 3 different Clinical Decision Support Systems (CDSS) (see Table 3 below).

Table 3 *CDSS tested at NHS Direct*

Software Company	CDSS	NHS Direct Site
Plain Software	Telephone Advice System	Lancashire
McKesson HBOC	Centrimax	Milton Keynes
McKesson HBOC	Personal Health Advisor PHA	North East

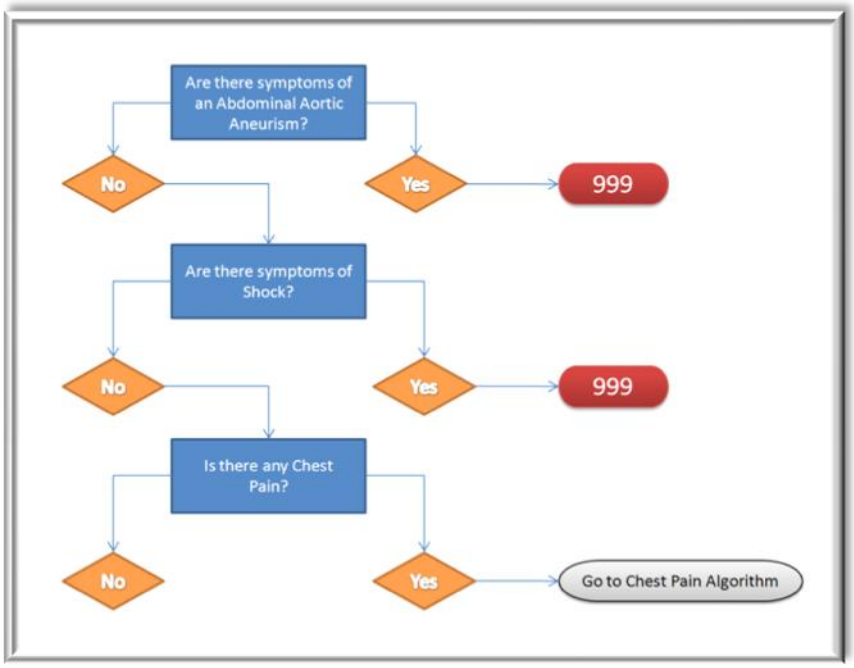
Between January and April 1999 the second wave expansion saw the service increase to 16 sites serving 20 million people (Munro, et al. 2001). The three different CDSS in use in the first wave were also deployed in the second wave sites which was intended to provide increased exposure of the systems in a live environment, providing valuable information for assessing which system should be installed across all NHS Direct sites in the future. Later in 1999 two other key developments took place a) NHS Direct Online was launched which provided access to a range of health information topics and b) a procurement exercise commenced to identify a single CDSS to be implemented across all NHS call centres (Winter and Thompson, 2003). Although the main objective of the newly launched Web Site was to provide clinically robust and up-to-date health information for internet users it also provided

the opportunity of managing demand to the telephone service by appropriately redirecting callers to the web site if the enquiry was concerning general health information. The procurement of a service wide CDSS was an important milestone in the development of the service and a response in part to the evaluation findings of the First Wave Sites. This evaluation commissioned by the Department of Health and conducted by the Medical Care Research Unit of Sheffield University concluded that;

> *'Respondents pointed out that highly prescriptive software might offer increased safety and appropriateness but might also increase call time and therefore increase operating costs, and possibly lead to deskilling of the nurses; conversely, less prescriptive software might decrease call times and therefore operating costs, and offer a clear role for the nurse, but possibly reduce safety and appropriateness'.* (Munro, et.al. 2001, p.68)

The evaluation also highlighted variations in outcomes between the 3 sites even when presented with the same clinical presentation (Florin and Rosen 1999, Munro 2001). The criteria for choosing the service wide CDSS focused on the safety, accuracy and consistency of the decision support provided along with usability and acceptance factors both with system and service users (Winter and Thompson, 2003). A bidding process was undertaken in 2000 for a £70 million contract over a 7 year period to supply the CDSS to NHS Direct (Cunningham, Green, Miles and Rigby, 2005). A new contender for the contract entered procurement process at this late stage, AXA Clinical Advice System (AXA CAS). Although this CDSS had been used extensively in the United States it had not been tested in a live environment in England at that point. The final shortlisted systems were tested using live and 'dummy' calls and the department of Health announced the winner in 2000 to be AXA CAS (Cunningham, Green, Miles and Rigby, 2005). The system had been chosen because of the rapid changes the suppliers had made to the program, high user acceptance and on average lower consultation lengths than the other CDSS sites (Cunningham, Green, Miles and Rigby, 2005). The new NHS Direct CDSS was renamed NHS CAS and was rolled out in a phased manner throughout 2000 and 2001. The fundamental characteristic of NHS CAS was and still is, an algorithm or protocol based decision support software that uses static decision trees. Therefore, there are no mathematical procedures within the software which determine the flow or the outcome of the consultation based on user input. The decision trees have been devised and revised by expert panels and predominantly follow a yes / no binary logic as illustrated by Figure 1 (p.14) which shows the first three question sets (Topics) in the NHS CAS Abdominal Pain algorithm (version 10).

Figure 1: *Illustration of the Binary Logic used in NHS CAS*



Government support for the expansion of NHS Direct was confirmed in the NHS Plan (Department of Health, 2000) which stated that the service would play a central role in providing healthcare to the public. The NHS Plan also introduced the terms 'gateway' and 'gate-keeper' to the future role of NHS Direct; gateway to In Hours healthcare services, gatekeeper to the Out of Hours services. Thus it was envisioned that NHS Direct would become much more integrated with other health providers than it had previously been. But the NHS Plan went further than this by announcing that NHS Direct would be available nationwide by the end of 2000 and that by 2004 the service would add Digital TV to the existing telephone and web based modes of access. NHS Direct continued to expand during this period opening more sites to cover the whole population of England. In 2002 The National Audit Office (NAO, 2002) published their review of NHS Direct, which after a period of rapid expansion and change was something of a 'stock take' of the progress the service had made in its first five years and a list of suggestions for future development. The report noted that NHS Direct had rapidly become the largest provider of telephone based healthcare advice in the world.

The NAO, (2002) report highlighted 3 key elements for Nurse Consultation at NHS Direct. Firstly some callers were having to wait too long to speak to a nurse, secondly variation was evident in advice given by NHS Direct staff, even in similar scenarios and thirdly, advice given was deemed cautious. These themes influenced the future performance management strategies at NHS Direct which focused on reducing the average consultation length in order to increase service accessibility and emphasise the authority of the nurse over the CDSS. This encouraged a move away from the clinician necessarily utilising all the specimen questions within any given algorithm to a stance which promoted discounting questions where there was a clinically sound reason for doing so. It was considered within the NHS Direct, that a verbatim approach to using NHS CAS algorithms had previously fostered an overly risk averse approach to consultations.

The variation in advice given by nurse advisors in similar scenarios had been established by a 'Mystery Shopper' service which delivered set scenarios to the live NHS environment for comparison within and across sites. Nurse advisors were not informed that the scenario was a 'Mystery Shopper' consultation and therefore would approach the presentation in the same way as a call from the general public. Linked to the issue of decision making consistency was 'appropriateness' of advice by NHS Direct Nurses. The NAO recommended that in order to validate NHS Direct advice appropriateness the service should;

'continue to monitor at a national level the appropriateness of advice given to callers and their compliance with it, and establish whether performance compares favourably with other front-line healthcare providers such as GPs.' (NAO, 2002, p.4).

NHS Direct responded to the review with plans to become the single point of access for GP Out of Hours services, establish a new digital TV service and become a Special Health Authority (self-governing and separate from the Department of Health)(Cunningham et.al., 2005). NHS Direct was established as a Special Health Authority in 2004 (UK Government, 2004). This not only addressed some of the issues raised by the NAO, (2002) report, but also more easily facilitated the introduction of a single, service wide call prioritisation system; the Call Streaming and Prioritisation Tool (CSPT). Previously, the various host trusts had implemented their own call prioritisation system (some trusts did not opt for any systematic prioritisation). With the introduction of CSPT, all callers to the service would henceforth be led through a series of protocols which quickly established if the caller was seriously ill and

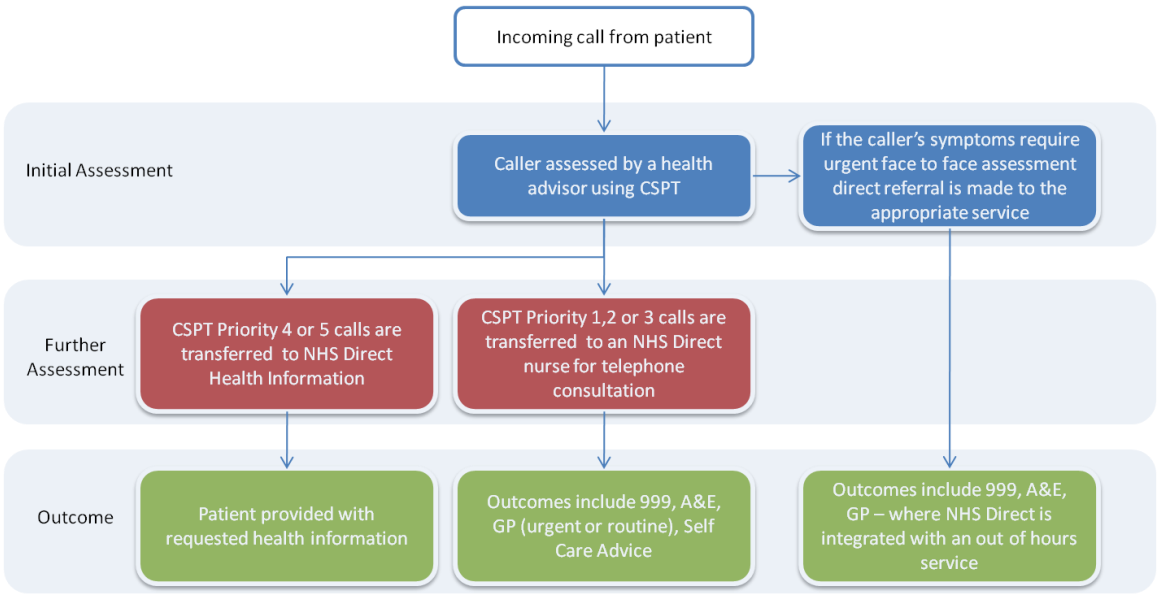
needed emergency or very urgent attention by an ambulance service, accident and emergency department or urgent GP service. CSPT was designed to be used by non-clinicians so that if an urgent response was required, the caller could be directed without delay to the appropriate emergency or urgent health care provider. However, there was still some variation since 'call streaming' for the caller was dependent on a number of local factors. NHS Direct had always had the ability to transfer a call directly to the ambulance service and this facility remained unchanged with the introduction of CSPT. If the CSPT recommendation was that the caller should attend an Accident and Emergency department (A&E) the caller would be directed to the nearest A&E department. This would also be the case if it was determined that the caller required an Urgent GP consultation, except in circumstances where NHS Direct provided the telephone consultation service for the Out of Hours GP service; whereby the consultation record could be sent directly via a technical link to the GP Out of Hours centre thereby booking a face to face consultation with a GP. However, there was from this point forward consistency in the following process; if an emergency or urgent response was not required the caller would now be assigned one of the following priorities;

- Priorities 1, 2 and 3 nurse consultation
- Priorities 4 and 5 Health Information.

Since CSPT was fully integrated into the NHS CAS system, once a priority had been determined the computer based record of the call would be automatically transferred to the appropriate priority queue which was viewed by all staff at the local call centre level. However, the telephony and computer systems were not integrated and therefore if the caller was assigned a Priority 1 category, the call was transferred to an available nurse at the local level. Callers assigned a Priority 2 or 3 would end the call and receive a call back from a Nurse Advisor and callers assigned a Priority 4 or 5 would receive a call back from a Health Advisor or Health Information Advisor respectively (see Figure 2 p.17).

By 2005 CSPT provided a systematic and service wide call prioritisation system to the NHS Direct service. Although a systematic approach to call prioritisation had been achieved, from the technical perspective the service was still operating as 22 different call centres predominantly serving their local communities. It was recognised that this was an inefficient way to deliver the service which furthermore did not facilitate the ability to flex rapidly to local or regional surges in demand. Therefore from 2005 NHS Direct embarked on a technical transformation which delivered a Virtual Contact Centre (VCC) infrastructure.

Figure 2: *The call streaming process at NHS Direct*



** Please note that the above graphic was devised for this thesis and does not appear in any publication.*

The VCC enabled a call from anywhere in the country to be intelligently routed to the next available Health Advisor or Nurse Advisor at any of NHS Direct call centres in England (BT, 2007).

NHS Direct's status as a Special Health Authority was abolished in 2007(UK Government, 2007) as the organisation began the consultation process to attain Foundation Trust status (NHS Direct, 2008). However, by late 2008 the Health Secretary Alan Johnson informed NHS Direct that Foundation Trust status could compromise the ability of the Department of Health to deploy the service to national health scares or national incidents (Duffin, 2008). NHS Direct is currently an NHS Trust.

1.3.2 What is Clinical Decision Support Software?

A broad definition of Clinical Decision Support Software (CDSS) is simply any computer programme that helps health care professionals make decisions (Shortliffe, 1990). However, this definition lacks resolution in that it can be applied to a wide range of software applications such as knowledge management systems (KMS) and analytical packages, or indeed any system which presents medical knowledge not necessarily designed to directly support clinical decision-making. A more successful overarching definition is a software programme which facilitates and augments the clinician's decision-making ability through automated mechanisms providing 'flagging' messages about the appropriate clinical response (Alexander, 2006).

Expert Systems

Expert systems are systems which emulate elements of human expert reasoning in order to solve problems or support decision making. Expert systems often employ Artificial Intelligence (AI) to compute an optimum solution to support the clinician. One of the earliest decision support systems was Acute Abdominal Pain Help (AAPHelp) developed at Leeds University which provided support to clinicians conducting assessments and deciding on the most appropriate outcome, faced with a patient presenting with acute abdominal pain (de Dombal, et al. 1972). AAPHelp contained a large database of patient cases collected from hospitals throughout the UK and Europe. The new patient's history and presenting symptoms were entered into AAPHelp which would then conduct an automated Bayesian analysis to establish the most probable diagnosis. However, two main problems were identified with AAPHelp; a) the analysis used in de Dombal's system was sometimes referred to as 'Naive Bayesian analysis' because symptoms in the database were treated as independent from one another when they may well be interrelated and b) clinicians did not readily accept the system seeing it as both a threat to their expertise and an encumbrance to clinical practice since the system was slow in responding and difficult to integrate into the daily routine of clinical practice (Taylor, 2006).

One of the best known early computer based systems was Mycin (Davis, Buchanan and Shortliffe, 1977) developed at Stanford University to diagnose and propose treatment for certain blood infections. The name MYCIN is not an acronym but is derived from the names of antibiotics, many of which have the suffix "-mycin". It was developed in part to address

the difficult clinical situation of having to wait 48 hours or more while blood cultures of the infecting organism were grown before establishing the requirement to treat; and if required, establishing the definitive treatment with the most appropriate antibiotic. But it was also developed to explore how expert clinicians decide to treat patients based on incomplete information. Mycin was one of the first 'Expert' systems and introduced more sophisticated artificial intelligence to decision support by performing a question and answer dialogue with the user (Boden, 2006). After requesting basic facts about the patient such as name, age, sex, race; Mycin requested further information such as suspected bacterial organisms, suspected sites of infection and the existence of relevant symptoms such as fever. Mycin's program was a 'production system' (MacCarthy, 1984) which is a collection of processes based on pattern matching and logical functions such as If – Then- And – Else. The whole procedure of inquiry and recommendation is constructed from iterative productions. MYCIN gave the clinician a proposed diagnosis detailing measures of uncertainty and explanations of why and how its recommendations were determined.

However, it is worth noting that MYCIN was never used regularly in the clinical setting. Mycin's designers concluded that clinicians were not likely to be highly motivated to use the system, that it was difficult to integrate the use of MYCIN into the clinical situation in a seamless manner and furthermore, the limitations of computer power in the mid 1970's severely undermined the user experience through long delays between input and output (Buchanan and Shortliffe, 1984).

Therefore the Expert Systems of the 1970's were characterised by simplistic mathematical approaches, long wait times for the system to execute the progame, a reluctance by the clinician to incorporate the system into every day practice and limited system usage. The progress of expert systems in the 1980's demonstrated cognizance of these problems and attempts were made to resolve them which is perhaps best illustrated by the introduction of 'DXplain'. DXplain was developed at the Massachusetts General Hospital/Harvard Medical School Laboratory of Computer Science and from the beginning was designed to be used by clinicians who did not have advanced skills and/or knowledge of computers (Barnett, Cimino, Hupp and Hoffer, 1987). The system developers claimed to have less ambitious but more realistic aims and objectives;

> *'DXplain does not attempt to make a single diagnosis to mimic the behaviour or replace the judgment of the expert clinician. DXplain has a less ambitious, but perhaps more attainable goal: to suggest a list of diagnoses that should be considered given a particular set of signs and symptoms'* (Barnett, Cimino, Hupp and Hoffer 1987 p68).

Furthermore, the developers proffered six essential criteria for a CDSS. The following list is taken from (Barnett, Cimino, Hupp and Hoffer 1987 p68).

1. Easy to use by physicians who have little or no computer background.
2. Based on comprehensive medical content.
3. Provide correct and accurate interpretations.
4. Justify its interpretations.
5. Be convenient to access from the physician's office, hospital or home.
6. Evolve and improve as a result of user criticism and analysis of user sessions.

Therefore DXplain had a greater focus upon ease of use, widespread clinical uptake and system evolution through user feedback, than its expert system predecessors. DXplain introduced a more extensive synonym and abbreviation recognition system, enhancing the user experience by making input more flexible. Importantly, inputs were processed quickly by the system, unlike the cumbersome usability aspects of the systems developed in the 1970's. The system was made widely available through a communications network (AMA/NET) and a user feedback mechanism was integrated so that users could easily suggest changes by electronic mail. By the mid 1990's DXplain was made available on the World Wide Web (WWW) (Barnett, et.al. 1998). DXplain uses Monte Carlo probabalistic algorithms, which means that the system creates random numeric attributes within realistic parameters from actual cases in the knowledge database thereby creating virtual random samples to more accurately represent the population (Hammersley & Handscomb, 1997). DXplain is still in use today and is accessed through the internet.

Protocol and Guideline Based CDSS

Not all clinical decision support systems are expert systems. In the context of telephone consultation Crouch (2002) has described two broad approaches to supporting clinical decision-making with CDSS;

- Protocol based - in which algorithms provide a predetermined pathway of questions and answers, which the user traverses. The algorithm has the

priority of the questions built into the structure of the algorithm itself, usually flowing from questions which determine if the caller needs an emergency or urgent response to determining less urgent scenarios. (example – NHS CAS)

- Guideline based – providing a series of prompts which can be freely navigated by the user, often facilitating the assessment of multiple symptoms at the same time. (example - Telephone Assessment System, Plain Software).

It is worth describing NHS CAS and the way it supports consultations as an example of a protocol based CDSS since the sample consultations for this study are taken from two NHS Direct sites, both using NHS CAS version 10.

1.3.3 NHS CAS

Before the Nurse Advisor commences a dialogue with a caller to the NHS Direct Service, the caller will first be greeted by a Health Advisor who will use the Call Streaming and Prioritisation Tool (CSPT) in order to prioritise the caller's symptoms. The Health Advisor will document all relevant information including demographics and will then send the electronic record to the appropriate NHS CAS (computer) queue while transferring the telephone call into a separate telephony queue. The telephone call is intelligently routed to the first Nurse Advisor available to take the call in any of the NHS Direct call centres in England.

The First Advice Queue in NHS CAS shows a list of all current callers waiting for a nurse assessment. Once the call is routed to the Nurse Advisor, the appropriate record can then be identified and opened. After key demographic information has been confirmed the Nurse Advisor will ask the caller about the reason for contacting the service (this initial description of symptoms by the caller is referred to by NHS Direct as the 'Offload'). Before an algorithm can be opened by the nurse advisor, the 'Past Medical History' screen must be completed detailing any on-going conditions, treatments and medications. Once the nurse advisor is aware of the specific main symptom the caller is presenting with, the appropriate NHS CAS algorithm can be chosen from a list. On opening the chosen algorithm, the assessment screens have the same format with the following 5 information boxes:

- **Question Topic:** The overarching descriptor of the specimen question or group of specimen questions. Example; 'Infant Respiratory Distress' is the first Topic in the Fever Toddler algorithm.

- **Specimen Question(s**): The guide questions that the Nurse Advisor can choose to use in the consultation with the caller. Nurse advisors are not compelled by NHS Direct to utilise all specimen questions, however if a specimen question is disregarded, the nurse advisor must have a compelling reason for not using it. Example; the following five specimen questions are displayed for the Infant Respiratory Distress Topic in the Fever Toddler algorithm
    - Gasping Breaths?
    - Extreme Pallor?
    - Grunting noises with each breath?
    - Irregular breathing with pauses?

- Turning bluish or pale around the lips?

- **Rationale**: This section provides the rationale for asking the specimen questions. The rationale is sourced from medical text books and expert panels.

  Co-Morbids: conditions that may be associated with the Topic currently being considered. These are conditions that the Nurse Advisor may wish to keep in mind in the context of specific symptoms the caller may have.

- **Free Text Box**: A free text box is available with each Topic so that the nurse advisor could if required; make notes associated with the specific caller responses to the specimen questions.

There is also an input section with 4 options:

- **Process** –chosen if the caller has said yes to any of the specimen questions within the Topic.
- **No** – chosen if the caller has confirmed that none of the symptoms referred to by the specimen questions is being experienced.
- **Uncertain** – chosen if the Nurse Advisor is unsure from the caller responses whether the symptoms in the specimen questions are present in the caller's condition or not.
- **Back** – chosen of the Nurse Advisor wishes to return to an earlier part of the algorithm. The 'Back' option returns the Nurse Advisor to the previous Topic.

Depending on the responses from the caller and the inputs from the nurse advisor, the algorithm will at some point display a recommended outcome (referred to by NHS Direct as the 'Disposition'). There are 4 areas of information or input on the Disposition screen;

- **Disposition** – such as 'GP Practice within 36 Hours'
- **Topic Advice** – advice associated with the caller's presentation (the algorithm chosen by the Nurse Advisor) or the disposition. This section is a list with check boxes. The Nurse Advisor will click on the items of advice that are given from the list.
- **Advice Given** – any item of advice checked (see above) will be displayed in

this section. This section can also accommodate free text.

- **Override Reason** – if the Nurse Advisor decides to recommend a different disposition to the one recommended, the reason must be specified here by choosing one or more reasons from a drop down list. Another, alternative disposition can then be selected.

NHS CAS does not use any mathematical models to determine the most appropriate advice. All algorithm end points have been predetermined and hard-wired into the algorithms; the urgency level and position of these end points have been determined by expert panels.

1.3.4 Clinical Cue Acquisition and Clinical Decision Making

The aim of this study is to determine if significant variation exists in clinical cue acquisition in the context of algorithm based CDSS telephone consultations at NHS Direct and if there is a correlation between clinical cue acquisition and the disposition. Therefore, it is useful to determine where clinical cue acquisition fits in decision-making theory.

Two theories which focus on intuition and analytical reasoning in decision-making are Cognitive Continuum Theory (Hammond, McClelland and Mumpower, 1980) and the Theory of Expertise (Dreyfuss and Dreyfuss, 1986). While both theories espouse intuition and analytical reasoning as the axes of decision-making, they differ markedly on the reasons why and how they are used in the decision-making process. Hammond, McClelland and Mumpower, (1980) proposes a continuum that links intuition and analysis asserting that the factors which influence to what extent the intuitive and/or analytical modes are used is the complexity and construction of the information presented. Therefore faced with a presentation which is simple, contains fewer required cues to process and where all of the salient cues are known; more analytical reasoning is likely to be used. Conversely, if the presentation is complex with many decision cues, a number of which are not available, the intuitive mode is more likely to be used. Dreyfuss and Dreyfuss (1986) advocate that the specific experience of the individual is the fulcrum which determines the balance between intuition and analysis. Therefore if the individual is inexperienced in dealing with a given situation they are more likely to rely on the facts and evidence gained through training and education, processing these facts analytically to support decision-making. Conversely, the individual with specific empirical experience of the given situation is more likely to utilise tacit processes, based on experiential classifications. Neither of the above theories has a strong focus on clinical cue acquisition, instead they concentrate on how judgement and decision-making operate on the information available. One major problem arises in attempting to locate clinical cue acquisition within either theory; both theories have intuition as the central operator of decision-making, yet neither theory adequately explains how intuition may influence clinical cue acquisition (or vice versa). Nonetheless, whether decision-making pivots around information complexity or the experience of the given practitioner, decisions are still dependent upon the quantity and accuracy of information gathered.

Other theories have focused on specific elements of decision making such as heuristics; the learned ‘rules of thumb’ which short cut complex probabilities first proposed by Tversky and Kahneman (1974). The study of heuristics has charted and classified intuitive processes,

formerly an area that was largely expressed as merely the binary opposite to analytical processes. Heuristics are strongly linked with clinical cue capture, since the efficacy of applying any 'rule of thumb' is dependent on the accuracy and extent of available information. Although it is worth pointing out there are a number of differing models with varying taxonomies (Gilovich, Griffin and Kahneman, 2002).

Elstein, Schulman and Sprafka (1978) proposed a 4 stage information processing model which explicitly refers to decision cue capture; 1) Cue Capture 2) Hypothesis Generation 3) Cue Interpretation and 4) Hypothesis Evaluation. Furthermore, Elstein found that cue acquisition was correlated with diagnostic accuracy. However, there are a number of different information processing models; (Carnevalli, Mitchell, Woods and Tanner 1984; Atkinson & Shriffin, 1968). Nonetheless, cue acquisition is conspicuous in all of them.

Two other prominent theories focus on the cognitive operators of the brain, Symbolic Manipulation (Chomsky, 1963); the transformation of symbols or operators according to syntactical rules and Connectionist theory (Rumelhart and McClelland, 1986; Smolensk, Mozer and Rumelhart, 1996): a dynamic network of units or nodes, spreading excitation or inhibition from an initial input in an iterative process. Both these theories have been prominent in the development of Artificial Intelligence. The decision-making processes of artificial intelligence are dependent on relevant cue acquisition. If irrelevant or inaccurate data is captured, the resultant decision is likely to be adversely affected.

The above theories are not an exhaustive list of decision making hypotheses but they illustrate the diversity of theories, which are sometimes presented in opposition to one another, often constructed from the perspective of a single discipline and commonly described using unique or reinterpreted nomenclature. In 'Classifying Clinical Decision Making: a unifying approach' (Buckingham and Adams, 2000) the authors introduce a general model of classification which defines decision-making activities common to all clinical domains. This theory suggests that all clinical decision-making has five iterative phases:

- Pattern Vector – all possible information that could be gathered about the patient.
- Feature Vector – a subset of the pattern vector which consists of all the information specific to the clinical presentation.
- Representation – how the clinician represents the feature vector in terms of understanding and priority.

- Classifier – judgement phase where the clinician classifies the condition of the patient.
- Decision – the outcome of the classifier is then matched to a decision category.

The Feature Vector in the model aligns with the specimen questions in NHS CAS algorithms since they have been devised by expert panels and are designed to provide prompts on all the salient issues related to the given symptoms being assessed.

Clearly in all decision-making models, information gathering (clinical cue acquisition) is an important element. It could be argued that in the telephone consultation setting, clinical cue acquisition is even more important since there are no visual cues to augment the Nurse Advisors clinical picture. Therefore, the deficit in visual cues will need to be compensated by enhanced verbal cue gathering.

Whichever decision-making theory is considered, effective clinical cue acquisition is a vital component of clinical decision-making.

2. Methods

2.1 Design

The two main aims of this study were:

1. To determine if the clinical cue acquisition varies significantly in NHS Direct consultations.
2. To determine if there is any significant associations between clinical cue acquisition NHS Direct consultations and the outcome (Final Disposition) of the consultations.

The secondary aim was

3. To explore any emergent themes of variability and risk relating to clinical cue Acquisition using NHS CAS.

Objectives

For aim 1 stated above;

a) Conduct difference tests on clinical cue acquisition grouped by NHS Direct site and Algorithm.

For aim 2 stated above;

b) Conduct a correlation test between clinical cue acquisition and the disposition.

For aim 3

Analyse data on clinical cue acquisition and discuss emergent themes.

These questions have been drawn from the literature which suggests that differences and inconsistencies exist in NHS Direct telephone consultations and especially the consultation outcome.

The study is a quantitative, cross-sectional, retrospective design in which audio recordings of NHS Direct Nurse consultations with callers from the general public were listened to. Two types of presentation and therefore algorithm were chosen; Abdominal Pain and Fever Toddler; calls were chosen randomly from these two presentations. Pragmatically, only two

algorithms could be included in the study since it was required that the algorithms were mapped in detail which then informed the construction of the data capture tool. These two presentations are frequently used algorithms at NHS Direct and therefore would facilitate an adequate sample size and provide the scope to analyse consultations for an adult presentation and a paediatric presentation. Two NHS Direct call centres were chosen for call sampling; Dudley and Milton Keynes, although calls to these call centres could originate from anywhere in England. The following variables were documented for each call, definition of the variable are also included:

- Clinical Cue Negative (CCA-) specimen questions.

  If a specimen question was not asked by the Nurse Advisor and no answer or reference to this question, either directly or indirectly occurred at any point in the consultation, it was classified as CCA-. Please note that if there was any background audio information during the consultation that clearly provided the information required by any given specimen question, the specimen question would be classified as clinical cue acquisition positive (CCA+). For example, if the specimen question was designed to elicit if a child was suffering from intense eye pain when exposed to bright lights and the Nurse Advisor has previously determined that the child was playing video games; this specific specimen question would be classified as CCA+, since the child could not conceivably be suffering from intense eye pain and be playing video games.

- NHS Direct Call Centre

  Two NHS Direct call centres were included in the study; Dudley and Milton Keynes.

- Algorithm

  Following the caller description of symptoms at the outset of an NHS Direct consultation, the Nurse Advisor chooses the most appropriate algorithms from the CDSS, NHS CAS. Two algorithms were included in the study, Abdominal Pain and Fever Toddler.

- Final Disposition

  The final advice given to the caller after the assessment. This is the outcome of the consultation. Final dispositions were categorised into 5 levels of urgency

- Total Available Specimen Questions

The total number of specimen questions and components of questions in the algorithm available to the Nurse Advisor during the consultation. Depending on caller responses and the Nurse Advisor input, various routes could be taken along the algorithm. Therefore, the number of specimen questions available to the Nurse Advisor would be dependent on responses and input even when using the same algorithm.

Difference Tests

It was assumed that the dependant variable (clinical cue acquisition) was unlikely to meet the assumptions of a parametric difference test. The *t* test is used to determine if significant differences occur by two groups. Since there are two call centres in the study and two algorithms, the *t* test would be appropriate at least in terms of groupings. However, it seemed unlikely that the count of CCA- specimen questions per consultation would comply with the definition of a 'continuous variable'. Nunally and Berstein (1994 cited in Hazard-Munro, 2001, p.125), defines a continuous variable as having at least 11 dichotomous and continuous levels. The CCA- counts may not have resulted in counts that were as high as 11. Parametric tests also require relatively normal distributions in order to yield valid results; an adequately normal distribution is often defined by skewness ÷ standard Error of skewness =< 1.96 (Hazard-Munro, 2001, p.44). The distribution of CCA- specimen questions was likely to be substantially positively skewed since a consultation could not have less than zero CCA- results, there would be substantial bunching of the data towards the zero figure. Although a successful data transformation of the skewness, such as square root or logarithmic transformations may have corrected the problem to within acceptable parametric tolerances, there was a risk that this might be difficult to achieve. Due to the above reasons it was deemed that the Mann Whitney U test, the non-parametric equivalent of the *t* test, was likely to be a more suitable difference test for the likely data characteristics of this study . The Mann Whitney U test can be performed on ordinal level data as well as continuous data, and is not vulnerable to skewed distributions since the assumption of a normal distribution is not required as this test compares the mean sum of ranks between groups, not the two means.

Correlation Test

The Pearson's correlation coefficient is a parametric correlation test that also requires relatively normal distributions and continuous variables. Therefore the same potential issues stated for difference tests would also apply to using this correlation test. Consequently a Spearman's rho test, the non-parametric equivalent of the Pearson's test was deemed the

most appropriate correlation test for the likely data characteristics in this study.

2.2 Sampling Frame

Since detailed coding and cross referencing of the questions asked by the nurse advisor with the specimen questions contained in the algorithm was required; two algorithms were chosen to transcribe in full from NHS CAS. Transcription of the detailed algorithms within NHS CAS is a labour intensive process and it was not practical to transcribe more than 2 algorithms. Detailed transcription of the algorithms was necessary in order to cross reference the acquisition of clinical cues with the specimen questions. Therefore the two algorithms in the study, Abdominal Pain and Fever Toddler were chosen because they were a) among the most prevalent presentations from callers to NHS Direct and b) they offered a breadth of consultation scenarios:

- Abdominal Pain – adult callers who spoke directly to the nurse regarding their symptoms.
- Toddler Fever – Patients aged between 1 and 4years, the consultation conducted by the parent or carer who described the child's symptoms to the nurse.

Randomly selected audio recordings of Nurse Advisor telephone consultations within the sample frame (n=250) were documented in the data collection tools devised for this study These consultations took place between June 1st 2006 and September 30th 2006 and were received by nurse advisors based at 2 NHS Direct call centres, Milton Keynes and Dudley. These two call centres were of similar size in terms of estates, infrastructure and numbers of full time equivalent staff. Furthermore they received similar volumes of calls from the general public via the 0845 4647 telephone number. However, they were managed on a day to day basis by a different regional management team.

Inclusion Criteria

- Consultations from the period June 1st 2006 and July 31th 2006
- NHS Direct consultations resulting from a call from a member of the general public via the 0845 4647 number.
- NHS Direct telephone consultations conducted by nurse advisors.
- Consultations conducted by nurse advisors at the Milton Keynes or Dudley call centres.
- Consultations in which the Abdominal Pain or Toddler Fever NHS CAS algorithm had been utilised by the nurse advisor.

- Consultations in which only one NHS CAS algorithm was utilised during the entire consultation.

Sampling

Although two call centres and two algorithms were chosen for the study, a random sampling technique was used within this sampling frame. A bespoke report was written in Crystal Reports v8 which interrogated the NHS CAS database returning all NHS Direct consultations that met the study inclusion criteria. In all 721 records were returned. The report contained the date and time the consultation commenced, the algorithm utilised and the NHS Direct site at which the telephone consultation took place. These data were exported into SPSS v12 and the random selection option was then used to select the study sample of consultations n=250.

2.3.1 Sample Size estimations for Non-Parametric difference tests

Although non-parametric difference tests are often used without reference to sample power, a sample size and power calculation was used prior to data collection to ensure adequate sample size. Furthermore, it was known that data collection would be very time consuming and may take up to one hour to gather and record all the required data for one case (one consultation recording). For this pragmatic reason it was considered a useful exercise to determine the lowest number of cases required to obtain an adequate power. The sample size and power estimation was carried out in a commercially available software package - PASS (Power Analysis and Sample Size) 2005. The calculator for the Mann-Whitney U test was accessed by clicking; Non-Parametric > Mann Whitney Test, from the test list on the opening screen.

The non-parametric adjustment is an adjustment that takes into consideration the type of non-normal distribution the data may fit. The 'Logistic' option was used since this returned the largest sample size requirement of the options. Since the type of distribution could not be known prior to the study, the Logistic adjustment offered the safest option for determining adequate sample size.

A number of assumptions were made in order to gain sample size estimation. It was assumed that the standard deviation of CCA- specimen questions would be 2 and that the smallest significant difference in means was set at 1 CCA- specimen question.

The results of the sample size estimation was that a sample size of *n*=250 (125 per group)

would give a sample power of 98.4%. Alpha, the risk of obtaining a false positive result would be α = 0.050 and Beta, the risk of obtaining a false negative would be β = 0.015. The sample size estimation also demonstrated that a sample size of 200 (100 per group) would also yield satisfactory alpha and beta likelihoods. However, the higher figure of *n*=250 was decided upon in order to provide a safety margin in the event that the standard deviation was higher than 2 which would have the effect of increasing the beta value.

2.3.2 Sample Size estimations for Spearman's Rho correlation tests.

The type of data collected meant that a number of variables were ordinal level data. Therefore a Spearman's Rho test for association would be the most appropriate. PASS 2005 does not have a specific Spearman's Rho sample size calculator so the inequality test for one correlation was used. This was deemed adequate as long as there would not be a high number of ties between the two ranked variables in question (Seigal and Castellan, 1998). The sample size estimation for an inequality test for one correlation was accessed in PASS 2005 by clicking; Correlation > One Correlation.

The results of this estimation were that *n*=250 would yield a sample power of 96% with α = 0.050 and β = 0.042

2. 4 Data Collection

Two data collection tools were devised for recording data.

1. Algorithm Profiles (AP's)

Visual maps of the two NHS CAS v10 algorithms included in the study (Abdominal Pain and Fever Toddler) were constructed in Microsoft Excel. These diagrammatic representations of the algorithms are where data was documented during listening to the consultation recordings. Specimen questions were coded and the number of clinical cues associated with the specimen question group (Question Topic), were indicated, showing the cumulative and individual number of cues for Question Topics throughout the algorithm.

Oblong cells were used to illustrate all question topics and end points. Cells were colour coded in order to lend clarity to the algorithm flow. For colour coding see Table 4 below.

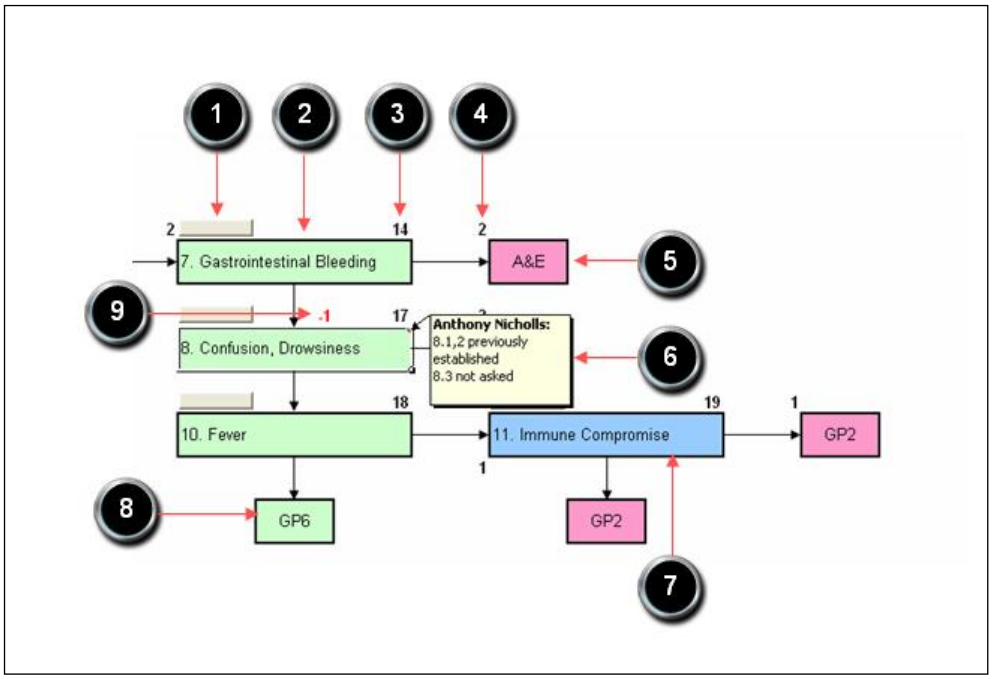
Table 4: *Cell colour coding in the data capture tool*

Question Topic followed during the consultation.	GREEN
Question Topic NOT followed during the consultation	LIGHT BLUE
Consultation Outcome	PINK
Go to another Specific Algorithm	GREY
Female Specific Questions Topics	YELOW
Male Specific Question Topics	DARK BLUE

Comments were attached to the Question Topic by using the Excel 'comment' facility. Attaching comments to Question Topics facilitated the recording of whether a specimen question was not utilised by the nurse advisor and whether an answer to that specific question had pre-occurred naturally in the consultation dialogue.

The overarching question topics were typed verbatim from the NHS CAS algorithms into a spreadsheet cell. Above that cell, a visual basic command button was created which when left clicked with the mouse would reveal the specimen questions associated with the topic; again, typed verbatim from NHS CAS. These specimen questions were the question guides that Nurse Advisers traversed during a telephone consultation (see Figure 3 p.35)

Figure 3: *Section of case #9 [Abdominal Pain Algorithm]*



Key to Figure 3 above.

1. Visual Basic 'Command' button which when clicked would display the specimen questions for that topic.
2. Question Topic – containing the specimen question or group of specimen questions which could be displayed by clicking on the command button above. The green colour of this box denotes that in this case the consultation flow included this topic.
3. Accumulative specimen questions – the total cumulative questions to that point in the algorithm including the current topic.
4. The number of specimen questions in the current topic.
5. The recommended NHS CAS Disposition.
6. Comments allowing documentation on utilisation of the questions.
7. Topic not encountered in this consultation hence the blue colour. The flow of this consultation was from Topic 10, to the Disposition of GP within 6 hours.
8. Final Disposition of the consultation. If this recommended disposition had been overridden by the nurse a comment box would be attached documenting the alternative disposition chosen.
9. Number of CCA- Specimen Questions (CCA-). Text shown in red and minus figures. Note that the comments box attached to this topic describes which specimen question was ignored.

The Verint call playback interface allowed the recording to be paused at any stage so that data could be entered into the AP without losing any data through attempting to type while listening to the playback. Standard flowchart symbols were not used for two main reasons;

1. Comments were required to be attached to certain question topics; which could not easily be achieved in another program without losing the functionality of a spreadsheet. Microsoft PowerPoint may have been a more obvious choice in order to graph the algorithms, however input of data is likely to have been more time consuming and transfer of data to the Study Database more challenging than using Excel.
2. Since the study database was to be created using Excel, if the AP's were also created in Excel, this would provide the possibility of linking data directly from the AP's to the Study Database.

2. Study Database

A study database was developed using Microsoft Excel (2003). The database followed a conventional spreadsheet format with variables in columns and cases in rows. Once all data for the consultation recording had been documented in the AP, it was then transferred to the Study Database.

2.5 Data Collection procedures

The randomly selected consultations (n=250) from SPSS had three data fields; the exact time of the consultation, the date the consultation took place and the NHS CAS algorithm selected by the Nurse Advisor conducting the consultation. This information was used to identify the consultation recording which could be accessed through the Verint software interface at NHS Direct. Verint is a call centre recording suite that records and stores calls and facilitates retrieval and playback of those calls. All calls to NH Direct are recorded through the Verint system. The call recording could be searched for by NHS Direct site, date and time thus allowing the call to be replayed in full. Once the correct call had been identified, the recording was played and any necessary documentation of data could be entered in the AP and SD as required. The recording could be paused at any point allowing data to be entered into the data collection tools without missing any of the recorded detail. The following detail of the consultation were documented;

1. The original sample report indicated in which of the two study sites the telephone

consultation had taken place, the algorithm used by the Nurse Advisor and the date and time the consultation commenced, this was now entered into the SD.

2. Using the AP the question topics utilised by the Nurse Advisor were indicated by changing the cell colour of the question topic used, to light green. Example –if the Nurse Advisor followed question topics 1 through 10, to the recommended Final Disposition of 'GP within 2 Hours'. All of the question topic cells and the Final Disposition cell would be changed from pale blue to pale green in the AP. This method of colour marking the areas of the NHS CAS algorithm traversed would clearly show the pathway taken along the algorithm in the consultation.

3. Using the AP for reference, the Nurse Advisors questions were compared to the specimen questions in the NHS CAS algorithm. If a specimen question was not utilised by the Nurse Advisor and if the caller had not indicated an answer to that question at any point in the consultation; this was documented as a CCA-specimen question. Example –, if upon reaching question topic 7 in the Abdominal Pain algorithm 'Haematemesis' (vomiting blood), the Nurse Advisor asks the caller if he/her had vomited blood or any material that looked like coffee grounds, but fails to ask the second part of the Haematemesis question topic 'did this occur within the last 6 hours', the duration of the symptom would not be established during the consultation. The above detail in this scenario would be documented as aCCA- specimen question. If the caller had confirmed that he had not vomited blood like material in response to the first part of the question, not asking the second part would not qualify as a missed or ignored cue since the answer was implicit in the response to the first question. This would also apply if the answer to this question had pre-occurred naturally during the consultation at an earlier point. In this situation it was assumed that the Nurse Advisor had remembered this answer and had therefore not needed to ask it when prompted by the specimen question.

4. Comments were inserted using the excel insert comment facility for two reasons; a) to document which specimen questions had not been utilised by the Nurse Advisor, and b) to document when a Nurse Advisor had chosen a different disposition to the one recommended in NHS CAS. Example – if specimen question 7a in the Abdominal Pain algorithm was not asked by the Nurse Advisor;

the comment '7a not asked' was attached to question topic 7 (Haematemesis). If the NHS CAS recommendation at the conclusion of the algorithm was GP within 2 hours, but the nurse chose to advise GP within 6 Hours; the comment 'Down-graded to GP-6' was attached to the disposition GP2, since the Nurse Advisor choose to alter the disposition to GP within 6 hours.

5. Following the completion of the documentation in the AP, the AP was given a sequential call number and saved to the hard drive.

6. The following data was then transferred from the AP to the SD; call centre, algorithm, final disposition, total number of specimen questions available during the consultation.

All data from the SD was then cut and pasted to SPSS v12. All analysis was conducted in SPSS.

2.6 Re-coding Procedures

Certain variables were re-coded. The re-coded variables along with the reason for recoding are listed below (Table 5).

Table 5: *Disposition Recoding to 5 Categories*

Disposition	Code
999 Ambulance as soon as possible	1
Accident and Emergency as soon as possible	1
Contact GP Service within 2 Hours	2

Table Continued on page 39

Table Continued on from page

Speak to GP within 2 Hours	2
Contact GP Service within 6 Hours	3
Speak to GP within 6 Hours	3
Speak to GP Next Working Day	4
Contact GP Service within 36 Hours	4
Contact Pharmacist	4
See Pharmacist	4
Home Care	5

The Final disposition variable was re-coded for two reasons. Firstly, at the time of data collection, The NHS CAS system had some duplicate dispositions such as 'Contact GP Service within 2 Hours' and 'Speak to GP within 2 Hours'. Although there is a slight difference in meaning between 'contact' the GP service and 'speak' to a GP; All Nurse Advisors were trained to advise the caller to Contact the GP service whichever version of this disposition was displayed. The reason for this is that the GP service may, after considering the caller's symptoms, decide not to invite the caller for a face to face consultation, or have a GP speak to the caller. Secondly, certain dispositions would have very low frequencies. An ordinal level of disposition urgency was preserved by the re-coding; 999 and A&E = emergency > GP 2 Hours = urgent primary care > GP 6 Hours = Primary care within 6 hours, GP next working day or within 36 hours = GP Routine > Contact Midwife, Pharmacist or Home Care advice = other health care professional or no primary care input required. For the purposes of the correlations the number order was reversed in order to make the direction of association clearer.

3. Determining discrete decision cues.

Classifying a specimen question as either CCA- or CCA+ rested in part upon the determination of discrete cues within the specimen questions.

1. Specimen Questions

The specimen questions within NHS CAS algorithms often bundle several discrete clinical cues into one question. The definition of a distinct clinical cue here is a clinical sign/symptom that could reasonably influence the clinician's judgement about the condition of the caller or the decision about what advice the caller should be given. Question topic number 1 in the Abdominal Pain algorithm (Possible Abdominal Aortic Aneurysm) has two specimen questions:

1. Pain began abruptly with a tearing, searing or ripping excruciating pain, deep along the backbone.
2. One or both legs gone completely dead, pale in colour or lacking in feeling.

However, these 2 questions refer to five distinct clinical cues. Firstly question 1, enquires about the onset of the pain, the type of pain experienced, and the specific location of the pain (3 distinct clinical cues, onset, type and location of pain). Question 2 enquires about feeling in the legs and colour of the legs (2 distinct cues, neurological deficit but also circulatory deficit).

These specimen questions are designed to establish if the caller is likely to be suffering from an Abdominal Aortic Aneurysm (AAA) which is a section of the aorta that becomes thin and weakened, bulging out into the abdominal space. The pressure of circulating blood may cause the aneurysm to rupture. A ruptured AAA causes severe internal bleeding which can often be fatal if emergency surgery to repair the rupture is not undertaken. Referring back to specimen question 1 above, the onset of pain may be an important indicator since pain associated with ruptured AAA's usually begins suddenly when the aneurysm ruptures. The type of pain associated with a ruptured AAA is usually very severe and often radiates to the backbone. Specimen question 2 explores any effects of neurological and circulatory compression that may result from severe internal haemorrhage. Each of these cues could influence clinical judgement and decision-making separately as well as in combination. The following scenarios further illustrate the importance of determining discrete clinical cues in the context of this study.

Scenario 1

- Pain progressed gradually
- Pain is mild
- Pain is not located deep along the backbone
- Normal feeling in both legs
- Normal colour in both legs

In this scenario, the absence of any of the classic symptoms of a ruptured AAA mean that it is reasonable for the Nurse Advisor to click on the 'No' button associated with the 'Possible AAA' question topic, thereby documenting that none of the symptoms referred to in the specimen questions are present. The NHS CAS Abdominal Pain Algorithm would then link to the next question topic 'Symptoms of Shock'.

Scenario 2

- Pain began abruptly
- Pain is mild
- Pain is not located deep along the backbone
- Normal feeling in both legs
- Normal colour in both legs

In this scenario, although the pain began abruptly, none of the other symptoms of a ruptured AAA are present. Although the Nurse Advisor may choose the same course of action as stated in scenario 1, the clinical picture is now different. The presence of a ruptured AAA would still seem unlikely since the pain is mild, does not radiate to the back, and there are no neurological or circulatory deficits to the legs. However, although the pain is mild it began abruptly which raises questions about the context of the onset of the symptom. A common reason for the sudden onset of pain is trauma. Therefore, the Nurse Advisor may choose to ask further questions about the onset of the pain at this point, or may carry on with the consultation in the knowledge that a relevant specimen question is included in the Abdominal Pain algorithm, further along the decision tree structure (question topic 4 provides the specimen questions relating to abdominal trauma). Therefore the mild abdominal pain which progressed gradually in Scenario 1 presents a different clinical picture to the mild abdominal pain that commenced abruptly in scenario 2. Only one clinical cue differed between the scenarios but this difference has the potential to independently influence the Nurse Advisors

judgement and decision-making. Specimen question 2 is perhaps less obviously, more than one discrete clinical cue than specimen question 1. Does the fact of neurological rather than circulatory deficit in the legs have a different effect open judgement and decision making in the context of a potential ruptured AAA. The answer is; probably not if the preceding questions had determined that the pain began abruptly, was excruciating and radiated to the back. However, if the pain had a gradual onset, was mild, did not radiate to the base of the spine; then the difference between a neurological and circulatory deficit in the lower limbs may have a different impact on the Nurse Advisors judgement and decision-making, especially in the context of past medical history or further context to the current episode. Therefore if a distinct clinical cue housed within a specimen question could potentially influence judgement and/or decision-making either in isolation or in combination with other cues, this was classified and labelled as a discrete clinical cue. For example, specimen questions 1 and 2 (above) from the Possible Abdominal Aortic Aneurysm question topic were labelled as follows;

1.1(a) Pain began abruptly with

1.1(b) tearing, searing or ripping excruciating pain

1.1(c) deep along the backbone.

1.2(a) One or both legs gone completely dead,

1.2(b) Pale in colour or lacking in feeling.

Note that the delineation between 1.1 parts and 1.2 parts reflects the 2 specimen questions as they appeared in the NHS CAS Abdominal Pain algorithm. This labelling or coding facilitated analysis of concatenated specimen questions since Nurse Advisor use or non-use of the specimen question or any of its component parts could be traced back to the form in which the question was presented in NHS CAS.

Some clinical cues were offered by the caller either without prompting by the Nurse Advisoror by the Nurse Advisor asking probing questions without the support of NHS CAS specimen questions. This could occur at the very beginning of the consultation when the caller gave a brief summary of their current symptoms, whereupon the Nurse Advisor may respond by asking probing questions about the information given. This dialogue took place before the specific NHS CAS algorithm had been launched and therefore before the Nurse Advisor had access the support of the specimen questions. The rationale for identifying these discrete clinical cues was exactly the same as the rationale used to identify discrete

specimen questions. Therefore if the caller stated that the abdominal pain had been present for 24 hours and was now more severe than at the onset; this was classified as 2 distinct clinical cues (1. duration of pain, 2. pain becoming more severe). If either of these clinical cues were different, this could potentially change the clinical picture in terms of clinical judgement and decision-making (i.e. pain subsiding rather than worsening).

All specimen questions in the two algorithms chosen for this study were analysed by a panel of three NHS Direct clinicians. A Nurse Practitioner, Nurse Educator and Medical Director, who considered what constituted a discrete clinical cue in all the specimen questions. The outcome of the panel was transferred to the Algorithm Profile template, so that each consultation within the study sample would have clinical cue acquisition measured by the same criteria every time. In all cases, if the discrete specimen question had not been acquired during the consultation either directly or indirectly, it would be classified CCA-. By adhering strictly to this rule, the reliability of classifying clinical cue acquisition was enhanced.

4. Ethical Considerations

Since the research activity was to take place in more than one Strategic Health Authority, the proposal was submitted for research ethics review via the central allocations system. The proposal was subsequently assigned to the designated committee (West Midlands Multi-centre Research Ethics Committee) in March 2005 and was given provisional approval subject to further information/clarification. A response to this request was submitted in June 2005 and a favourable ethical opinion was gained on 1st July 2005; REC reference number 05/MRE07/17 (Appendix A).

Listening in to recorded calls at NHS Direct is a daily, routine activity and an important part of quality assurance. At the time of data collection part of the author's role was to conduct random audits of clinical calls.

Title Modification

The original thesis proposal submitted for ethical consideration was designed to fulfil the requirements of the degree of Doctor of Philosophy. Data collection for the first of the three elements of the study was completed following the agreed and authorised protocol. However, due to a family illness and increased work commitments that prevented further progress along the planned timelines, it became clear that the study could not be completed in its entirety. It was therefore agreed with my Academic Supervisor that the first element from the original proposal (with data collection already concluded) should be written and submitted in partial fulfilment of the Universities requirements for the degree of Masters of Philosophy.

It was also decided that the original title required modification in order to best reflect the goals and objectives of the specific element brought forward from the original proposal.

Original Title

'A 12 month prospective observational study to assess how nurses utilise clinical decision support software to assess and process clinical cues in the tele-consultation setting.'

Revised Title

‘Do algorithms provide consistency in clinical cue acquisition in telephone consultation at NHS Direct?’

5. Intellectual Property Rights

The algorithm structure, specimen questions and clinical content of NHS CAS is the Intellectual Property of Clinical Solutions.

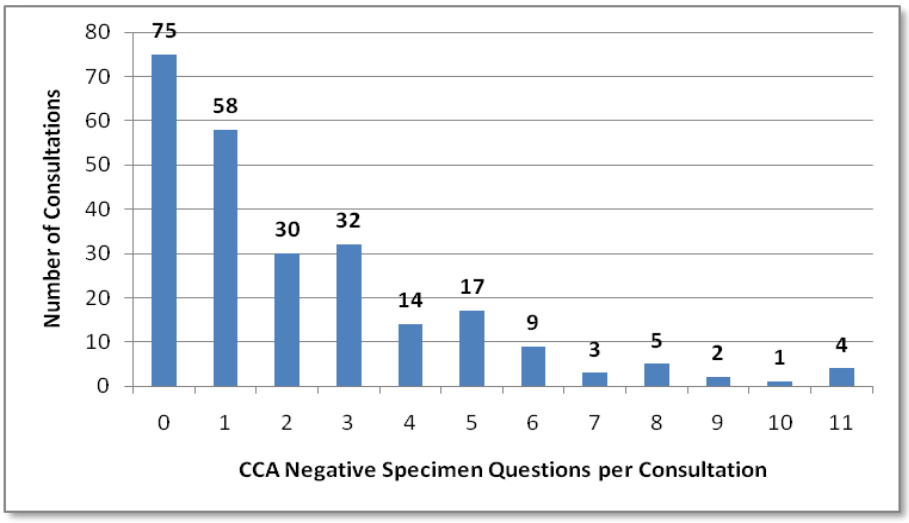
As such, any algorithm structure, specimen question or clinical content from NHS CAS must not be published, transmitted, sold or in any way exploited without the express permission of Clinical Solutions and NHS Direct.

6. Results

6.1 Clinical Cue Acquisition Descriptive Statistics

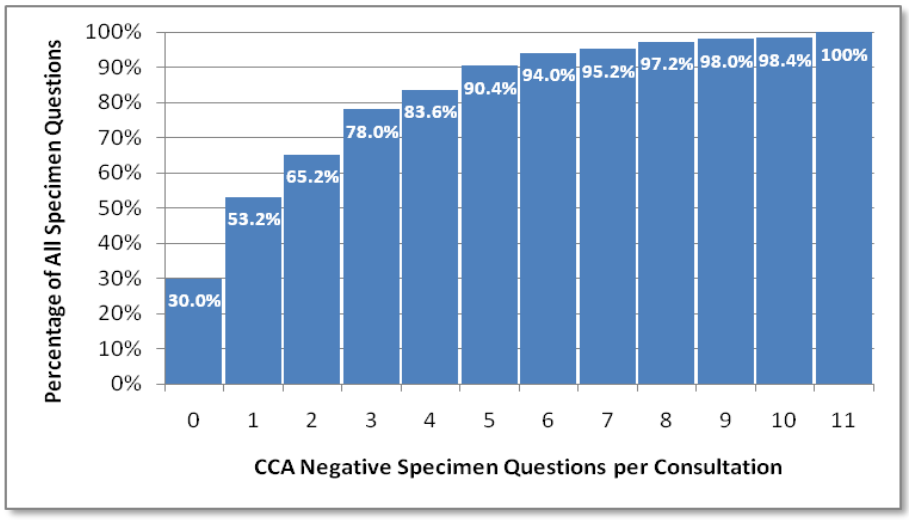
In 30.0% (75/250) of all telephone consultations studied, all the specimen questions available were Clinical Cue Acquisition Positive (CCA+). For the definition of CCA+ please refer to p? In 175 consultations, 1 or more specimen questions were Clinical Cue Acquisition Negative (CCA-). For the definition of CCA- please refer to p? Chart 1 (below) illustrates the frequency of CCA- specimen questions per consultation. For full descriptive statistics of CCA- Specimen Questions see Appendix B1.

Chart 1 *Number of Clinical Cue Negative Specimen Questions per consultation*



Across the 250 consultations, 6,501 specimen questions were available to Nurse Advisors using NHS CAS; the overall mean number of specimen questions available per consultation was 26 (See Appendix for full descriptive statistics). Overall, 91.66% (5,559/6,501) of specimen questions were CCA+, 8.34% (542/6,501) were CCA-. Chart 2 (p.48) illustrates the cumulative percentage of CCA- specimen questions by CCA- frequency.

Chart 2 - *Cumulative Percentage of Clinical Cue Negative Specimen Questions by frequency per consultation*

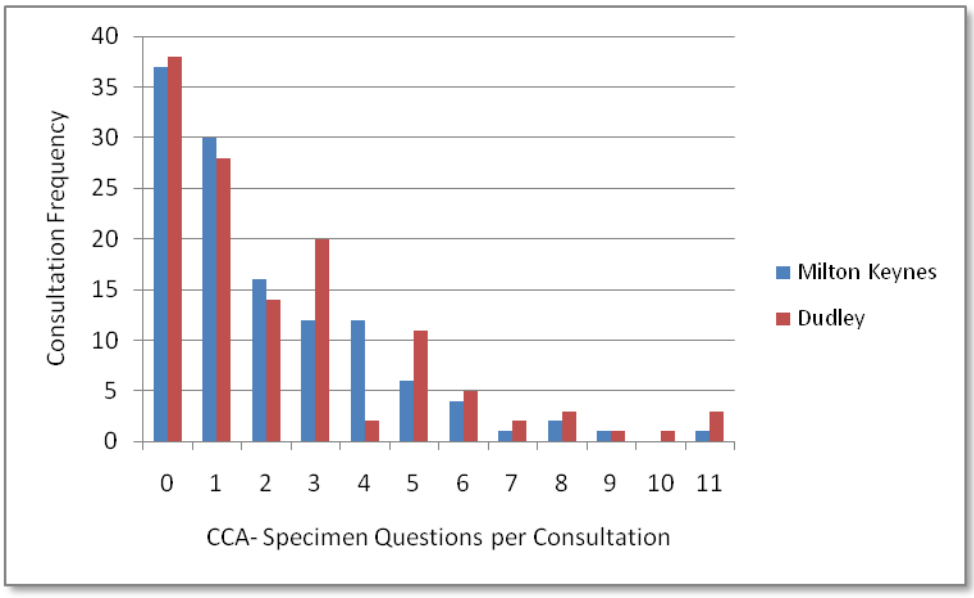


The mean number of CCA- specimen questions per consultation across both algorithms was 2.2. The mean number of available specimen questions across both algorithms was 26.

6.2 Clinical Cue Acquisition by NHS Direct Call Centre

Clinical cue acquisition in telephone consultations did not differ significantly between NHS Direct call centres (U=7442, Z= -.655, p=0.513). Chart 3 (below) illustrates clinical cue acquisition by Call Centre (Appendix B3).

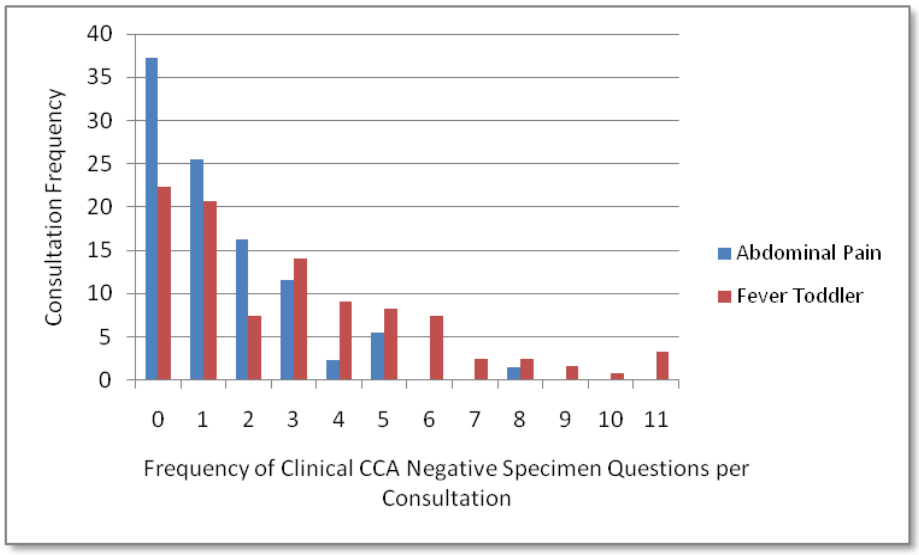
Chart 3 – *CCA- Specimen Questions by Call Centre*



6.3 Clinical Cue Acquisition by Algorithm

Clinical Cue Acquisition differed significantly by Algorithm (U=5314, Z=-4.457, p=<0.001), see Appendix B4. In the Abdominal Pain algorithm, 48 consultations were CCA+ compared to 27 CCA+ consultations in the Fever Toddler algorithm. Also, in the Abdominal Pain algorithm no consultation had more than 8 CCA- specimen questions whereas 7 consultations had between 9 and 11 CCA- specimen questions (see chart 4 below). The mean number of available specimen questions per consultation was 32 in the Fever Toddler Algorithm compared to 19 in the Abdominal Pain Algorithm (see Appendix B5.1 and Appendix B5.2 respectively).

Chart 4 – *CCA- Specimen Questions by Algorithm*

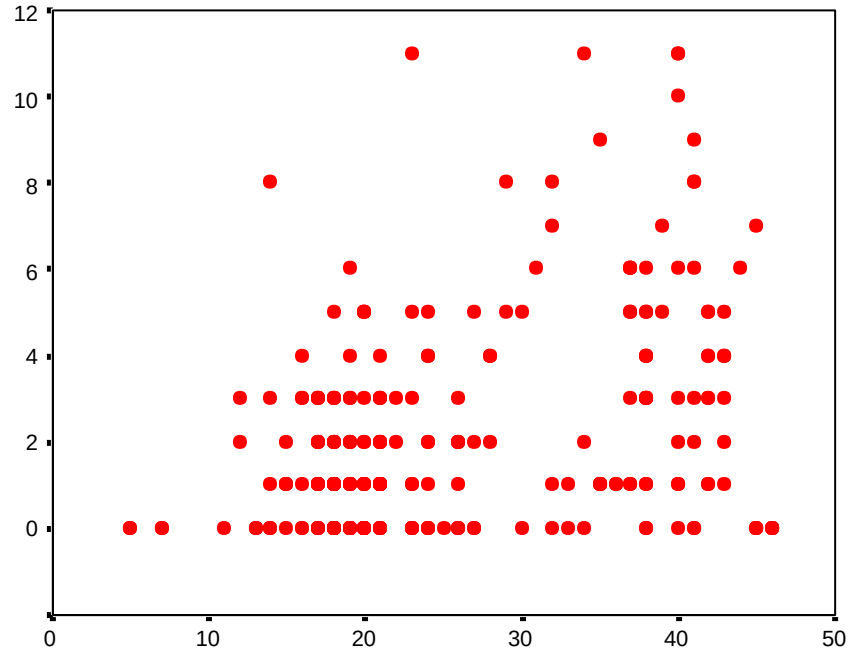


6.4 Correlation: Clinical Cue Acquisition with Disposition

A Spearman's rho test demonstrated a significant correlation between clinical cue acquisition and the disposition (r= 0.230, p=<0.001), see Appendix B6. The highest percentage of CCA+ consultations by disposition was 'Emergency' 66.6% (10/15). The lowest percentage of CCA+ consultations occurred in 'Routine GP or Health Professional' dispositions. However, caution should be exercised when interpreting this result since the mean number of Available Specimen Questions is higher in lower urgency dispositions (see Appendix B7); in 'Emergency' dispositions the mean number of available specimen questions is 14.6 rising to a mean of 36.7 in 'Home Care' dispositions. Since data for both these variables were

collected for this study, a Spearman's rho test was performed which demonstrated a significant correlation between CCA- specimen questions and the number of Available Specimen Questions per consultation (r= 0.307, p=<0.001), see Appendix B8. In the scatter plot (Chart 5 below) 17 out of the 20 consultations in which there were 6 or more CCA-specimen questions are shown to have occurred in consultations that had more than 25 available specimen questions.

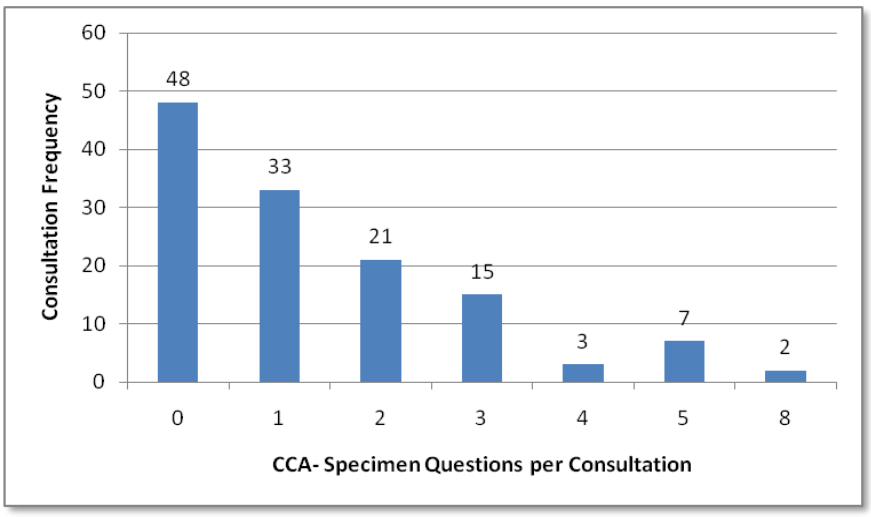
Chart 5 – *Scatter Plot of CCA-Specimen Questions and Total Available Specimen Questions per Consultation*



6.5 High Frequency Clinical Cue Negative Consultations (Abdominal Pain)

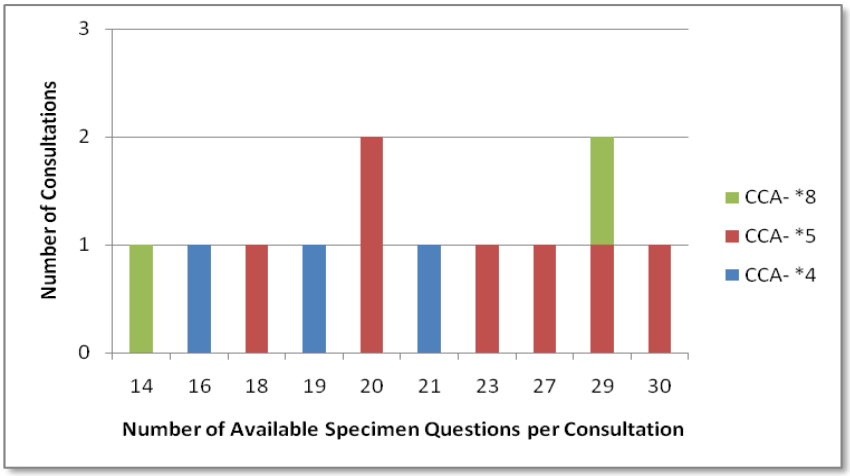
In consultations where the Abdominal Pain algorithm was used, 12 cases had between 4 and 8 CCA- specimen questions. Chart 6 (p. 51) illustrates the number of CCA- specimen questions by frequency of consultation, see also Appendix B9.

Chart 6 –*Clinical Cue Acquisition Negative Consultations (Abdominal Pain)*



In consultations where there were 4 to 8 CCA- specimen questions; between 14 and 30 specimen questions were available during the consultation. Chart 7 (below) illustrates the number of CCA- specimen questions by the number of available specimen questions in the consultation. For full tabulations see Appendix B10.

Chart 7 –*Clinical Cue Acquisition Negative Consultations (CCA- 4 to 8) by available Specimen Questions (Abdominal Pain)*



Two of the Abdominal Pain consultations contained the highest CCA- count of 8. These are described in detail below.

In all Case Profiles, only the CCA- specimen questions are described. Unless otherwise stated all other specimen questions were CCA+. For a full table and description of specimen questions in the Abdominal Pain algorithm see Appendix B11 and Appendix B12.

Case #170

- NHS Direct Call Centre = Dudley
- Number of specimen questions available to the Nurse Advisor = 29
- Number of CCA- specimen questions = 8
- Disposition = Home Care
- CCA- profile

  One element of the 'Symptoms of Shock' Topic was not established (2a. Does the caller have cool and clammy skin?).

  Two elements of the 'Abdominal Trauma' Topic were not established (4.1 Has there been an injury caused by a blow or blunt object? 4.2 Has there been an injury to the area from a significant fall?).

  Neither of the two 'Testicular Pain/Swelling' elements were established (41.1 Pain or swelling to one or both testicles? 41.2 Swelling, pain and redness of the scrotum?).

  Neither of the two 'Symptoms of Shingles' elements were established (51.1 Very uncomfortable burning sensation of the skin in the area when stroked with a light touch? 51.2 Presence of small blisters in clusters surrounded by a red halo in the area of pain?).

  The 'Immune Compromise' Topic was not established (Has the individuals doctor or health care advisor recommended early assessment due to an underlying condition if there are any symptoms of possible infection?).

- This consultation was referred to the Call Centre Supervisors for further review.

Case #183

- NHS Direct Call Centre = Dudley
- Number of specimen questions available to the Nurse Advisor = 14
- Number of CCA- specimen questions = 8
- Disposition = GP Routine

- CCA- profile

  One element of the 'Possible Abdominal Aortic Aneurysm' Topic was not established (1.2a. One or both legs gone completely dead?).

  None of the 'Abdominal Trauma' Topic elements were established (4.1 Has there been an injury caused by a blow or blunt object? 4.2 Has there been an injury to the area from a significant fall? 4.3 Has there been an injury caused by being crushed?).

  One of the elements for the 'Gastrointestinal Bleeding' Topic was not established (7.1 Passing red or maroon coloured or black-tar coloured bowel movements?).

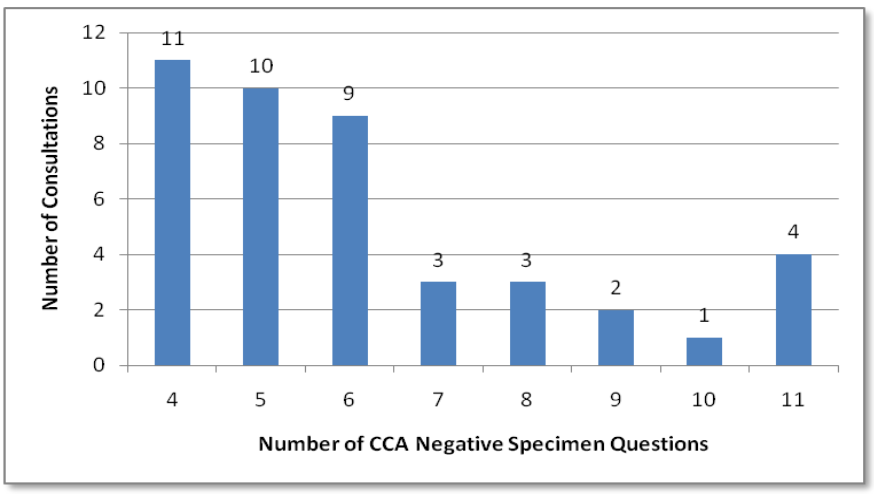
  None of the 'Confusion, Drowsiness' Topic elements were established (8.1 Any loss of consciousness? 8.2 Confusion or not knowing where they are or what they are doing? 8.3 Excessive sleepiness or feeling drowsy?).

- This consultation was referred to the Call Centre Supervisors for further review.

6.6 High Frequency Clinical Cue Negative Consultations (Fever Toddler)

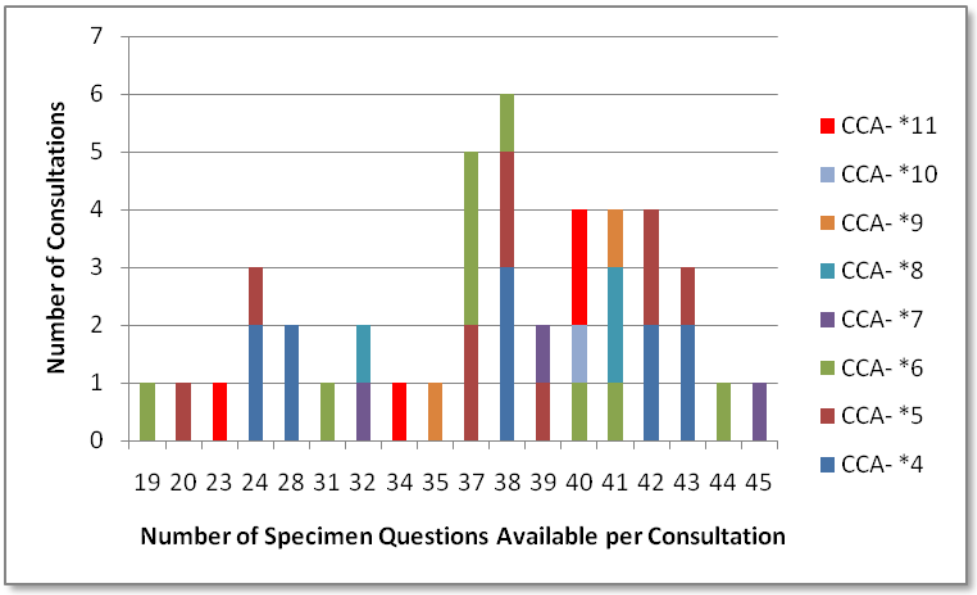
In consultations where the Fever Toddler algorithm was used, 43 cases had between 4 and 11 CCA- specimen questions. Chart 8 (below) illustrates the number of CCA- specimen questions by frequency of consultation (see Appendix B13).

Chart 8 – *High Clinical Cue Acquisition Negative Consultations (Fever Toddler)*



In these consultations there were between 19 and 45 specimen questions available. Chart 9 (p.54) illustrates the number of CCA- specimen questions by the number of available specimen questions in the consultation (see Appendix B14).

Chart 9 – *High Clinical Cue Acquisition Negative Consultations by available Specimen Questions (Fever Toddler)*



Four of the Fever Toddler consultations contained the highest CCA- count of 11. These are described in detail below.

Case #31

- NHS Direct Call Centre = Dudley
- Number of specimen questions available to the Nurse Advisor = 40
- Number of CCA- specimen questions = 11
- Disposition = Home Care
- CCA- profile

Two elements of the 'Infant Respiratory Distress' Topic were not established (1.2 Extreme Pallor? 1.3 Grunting noises with each breath?).

Three elements of the 'Child Meningeal Symptoms' Topic were not established (4.2 Distress or severe eye pain with exposure to light? 4.3 Intense headache? 4.4 Mental Confusion or difficult to rouse?).

Four elements of the 'Toddler Cortical Neurological Symptoms' Topic were not established (7.2 More floppy/limp than usual for him/her? 7.3 Crying differently to normal? 7.4 Irritable for over 4 hours? 7.5 Responds less to what is going on around him/her?).

One element of the 'Toddler Risk of Dehydration' Topic was not established (8.4 Has

not passed any urine over the last 8 to 12 hours?).

The ‘Child Immune Compromised’ Topic was not established (Has their doctor or other health advisor recommended early assessment of the child due to an underlying condition if there are symptoms of possible infection?).

Case #97

- NHS Direct Call Centre = Dudley
- Number of specimen questions available to the Nurse Advisor = 40
- Number of CCA- specimen questions = 11
- Disposition = GP Same Day
- CCA- profile

One element of the ‘Infant Respiratory Distress’ Topic was not established (1.2 Extreme Pallor?).

Two elements of the ‘Child Meningeal Symptoms’ Topic were not established (4.3 Intense headache? 4.4 Mental Confusion or difficult to rouse?).

The ‘Toddler Bloody Stools’ Topic was not established (6. Has there been frank blood, not streaks, mixed with the toddler’s stools or in the nappy?)

Three elements of the ‘Toddler Cortical Neurological Symptoms’ Topic were not established (7.1 Sleepy or difficult to awaken compared to usual? 7.3 Crying differently to normal? 7.4 Irritable for over 4 hours?).

The ‘Care Giver Intuition’ Topic was not established (10. Does the carer think that the child looks especially ill or sicker than with other illnesses?)

The ‘Child Testicular/Groin Swelling’ Topic was not established (13. Are one or both of the child’s testicles painful or swollen?). This consultation was regarding a male toddler.

The ‘Teething Toddler’ Topic was not established (50. Is the toddler teething?).

Case #151

- NHS Direct Call Centre = Milton Keynes
- Number of specimen questions available to the Nurse Advisor = 23
- Number of CCA- specimen questions = 11
- Disposition = GP 2 Hours
- CCA- profile

Two elements of the 'Infant Respiratory Distress' Topic was not established (1.2 Extreme Pallor? 1.5 Turning bluish or pale around the lips or fingernails?).

Three elements of the 'Child Meningeal Symptoms' Topic were not established (4.1 Not able to touch chin to chest? 4.2 Distress or severe eye pain with exposure to light? 4.4 Mental Confusion or difficult to rouse?).

Three elements of the 'Toddler Cortical Neurological Symptoms' Topic were not established (7.1 Sleepy or difficult to awaken compared to usual? 7.2 More floppy/limp than usual for him/her? 7.3 Crying differently to normal?).

Three elements of the 'Toddler Risk of Dehydration' Topic were not established (8.2 Has had more than 8 episodes of diarrhoea during the last 8-12 hours? 8.3 Has refused to drink their usual fluids during the last 8-12 hours? 8.4 Has not passed any urine over the last 8 to 12 hours?).

Case #176

- NHS Direct Call Centre = Dudley
- Number of specimen questions available to the Nurse Advisor = 34
- Number of CCA- specimen questions = 11
- Disposition = Home Care
- CCA- profile

Two elements of the 'Infant Respiratory Distress' Topic was not established (1.2 Extreme Pallor? 1.5 Turning bluish or pale around the lips or fingernails?).

Two elements of the 'Child Meningeal Symptoms' Topic were not established (4.2 Distress or severe eye pain with exposure to light? 4.4 Mental Confusion or difficult to rouse?).

Three elements of the 'Toddler Cortical Neurological Symptoms' Topic were not established (7.3 Crying differently to normal? 7.4 Irritable for over 4 hours? 7.5 Responds less to what is going on around him/her?).

Two elements of the 'Toddler Risk of Dehydration' Topic were not established (8.3 Has refused to drink their usual fluids during the last 8-12 hours? 8.4 Has not passed any urine over the last 8 to 12 hours?).

The 'Care Giver Intuition' Topic was not established (10. Does the carer think that the child looks especially ill or sicker than with other illnesses?)

The 'Not Tolerating Normal Fluids' Topic was not established (16. Is the individual able to drink fluids and keep them down?).

6.7 Ten Most Frequent CCA- Specimen Questions – Abdominal Pain

The most frequently disregarded specimen question in the Abdominal Pain algorithm was;

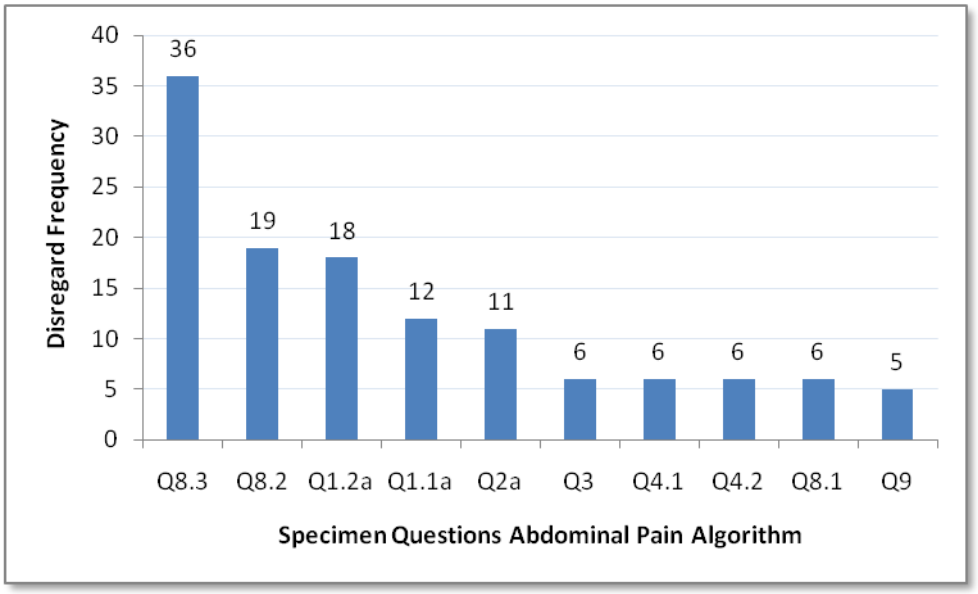
8.3 Excessive sleepiness or feeling drowsy?

This question was disregarded by the Nurse Advisor in 27.9% (36/129) consultations and was one of three questions from the 'Confusion, Drowsiness' Topic. The other two questions in this Topic were also high frequency CCA- specimen questions:

8.1 Any loss of consciousness (passed out)? (CCA- in 4.6% (6/129) of consultations.)

8.2 Confusion or not knowing where they are or what they are doing? (CCA- in 14.7% (19/129) of Abdominal Pain consultations.)

Chart 10 – *10 Most Frequent CCA- Specimen Questions (Abdominal Pain)*



See chart 10 above for the 10 most frequent CCA- specimen questions in this Algorithm.

In 4 Abdominal Pain consultations, none of the specimen questions from the 'Confusion Drowsiness Topic were utilised by the nurse (2 were GP Same Day dispositions and 2 were GP Routine).

In total 33.5% (65/182) of all CCA- specimen Questions in Abdominal Pain consultations were from the 'Confusion, Drowsiness' Topic.

The first Topic in the Abdominal Pain algorithm is 'Possible Abdominal Aortic Aneurysm' and 2 specimen questions from this Topic were the 3rd and 4th most frequent DSQ's in this algorithm;

1.1a. Pain began abruptly? [CCA- in 9.7% (12/129) Abdominal Pain consultations].

1.2a. One or both legs gone completely dead? [CCA- in 13.9% (18/129 Abdominal Pain consultations]

Some element of the 'Possible Abdominal Aortic Aneurysm' Topic was utilised by the Nurse Advisor in all Abdominal Pain consultations. In total 16.5% (30/182) of all CCA- specimen questions in Abdominal Pain consultations were from the 'Possible Abdominal Aortic Aneurysm' Topic

Specimen question 2a (part of the 'Symptoms of Shock' Topic) was disregarded in 11 Abdominal Pain consultations;

2a. Cool and clammy skin? [CCA- in 8.5% (11/129) Abdominal Pain consultations].

One of the two elements in the 'Symptoms of Shock' Topic were asked in all Abdominal Pain consultations.

Specimen question 3 ('History of Chest Pain' Topic) is a single specimen question topic and was CCA- in 4.6% (6/129) Abdominal Pain consultations.

3. Does the individual have chest pain with their symptoms?

Specimen questions 4.1, 4.2 (part of the 'Abdominal Trauma' Topic), were each CCA- in 4.6% (6/129) Abdominal Pain consultations.

4.1. Injury caused by a blow or blunt object?

4.2. Injured the area from a significant fall?

In 3 consultations none of the three elements to this Topic were utilised by the Nurse Advisor.

Specimen question 9 is a single specimen question Topic ('Fever' Topic) and was CCA- in 3.8% (5/129) of Abdominal Pain consultations;

9. Does the individual have a fever (temperature over 38.3Cor 101F) or do they feel hot or shivery.

6.8 Ten Most Frequent CCA- Specimen Questions – Fever Toddler

The most frequently CCA- specimen question in the Fever Toddler algorithm was;

4.3 Intense Headache?

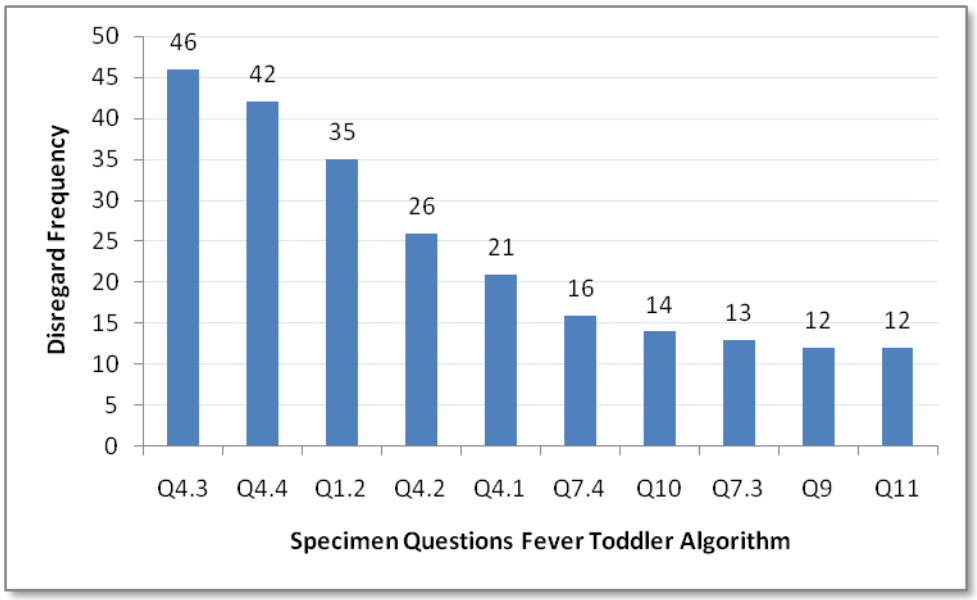
This question was CCA- in 38% (46/121) consultations and was one of four questions from the 'Child Meningeal Symptoms' Topic. The three other specimen questions from this Topic were also high frequency CCA- specimen questions (see Chart 11 p.59):

4.1 Not able to touch chin to chest

4.2 Distress or extreme eye pain with exposure to light?

4.4 Mental confusion or difficult to rouse?

Chart 11 – *10 Most Frequent CCA- Specimen Questions (Fever Toddler)*



In total 38.3% (135/352) of all CCA- specimen questions in the Fever Toddler algorithm were from the 'Child Meningeal Symptoms' Topic.

The first Topic in the Fever Toddler algorithm is 'Infant Respiratory Distress' and 1 specimen question from this Topic was the 3rd most frequent CCA- in this algorithm;

1.2. Extreme pallor?

Two of the top ten most frequent CCA- specimen questions formed part of the 'Toddler Cortical Neurological Symptoms' Topic;

7.3 Crying differently to normal, e.g. persistent weak, moaning, high pitched cry?

7.4 a) Irritable for over 4 hours,

b) not calm when held, rocked or cuddled:

The specimen questions 7.3 and 7.4 above were CCA- in 13 and 16 consultations respectively.

Specimen questions 9, 10 and 11 were all single question Topics and were CCA- in 12, 14 and 12 consultations respectively;

9. Does the child have a swelling or lump on either side of the groin?

10. Does the carer think that the child looks especially ill or sicker than with other

illnesses?

11. *Has their doctor (or other health adviser) recommended early assessment of the child due to an underlying condition, if there are symptoms of possible infection?*

7. Discussion

7.1 General Observations

Although in the majority (70%) of consultations in the study, one or more specimen questions were CCA-; across all consultations 91.6% of specimen questions were CCA+. Therefore although the caller to NHS Direct is more likely to be involved in a consultation in which one or more specimen questions is not addressed by the Nurse Advisor, they are nonetheless likely to have most of the clinical cues specified within the given NHS CAS Algorithm, acquired by the Nurse Advisor during the consultation. The fact that 70% of consultations did not have a complete CCA+ profile as defined by this study may at face value appear alarming in terms of clinical risk. After all, the specimen questions contained in NHS CAS Algorithms have been devised and constructed by expert clinical panels and the associated clinical cues which they are designed to elicit are intended to provide the Nurse Advisor with the most complete and relevant background picture upon which to exercise their judgement and decision-making. However, the precise context of every CCA- specimen question is critical in understanding any associated clinical risk. Section 8.2 below considers the implications of the difference test results, section 8.3 (p) discusses the extent to which clinical risk can be reasonably assigned to CCA- specimen questions.

7.2 Differences in Clinical Cue Acquisition

Cue Acquisition by NHS Direct Call Centre

The fact that there was no significant difference in Clinical Cue Acquisition between the two NHS Direct call centres is surprising since at the time of data collection, there was no NHS Direct national standardised induction, development or performance management programmes for the service. Therefore differences in the managerial approach between call centres could have been expected to yield different cue acquisition profiles. Also, although not included in the data for this study, it was apparent during data collection that Nurse Advisors at the Milton Keynes call centre were generally more directive in their use of specimen questions during consultations. Often the caller to this call centre was allowed little time to digress from the specimen question asked or to present information in a sequence that was out of synchronisation with the Algorithm flow. On numerous occasions Nurse Advisors at the Milton Keynes call centre determinedly and persistently requested that the caller answer only ‘Yes’ or ‘No’ to the questions asked and not to elaborate further. Whereas, Nurse Advisors at the Dudley call centre generally allowed expansive responses

which often included clinical cues other than had been raised by the specimen question asked at that point; cues which were sometimes located in another specimen question further along the Algorithm. Nurse Advisors at the Dudley call centre generally accommodated occurrences of un-sequential clinical cues. Given this noticeable difference in approach to conducting NHS Direct consultations, it seems surprising that no significant difference in clinical cue acquisition was detected between the two call centres. One possible explanation is that this noticeable difference in approach simply yields very similar clinical cue acquisition profiles. In other words the caller may be managed through the consultation in a very dissimilar way between call centres, but nonetheless, the same level of clinical cue acquisition is achieved. A larger study than the one conducted here, involving several NHS Direct call centres would facilitate greater understanding of different managerial approaches and cultures and the affect they may have on clinical cue acquisition.

Cue Acquisition by Algorithm

The difference between clinical cue acquisition by Algorithm was striking. Far more specimen questions were CCA- in the Fever Toddler, rather than the Abdominal Pain Algorithm. Four factors that may have some explanatory credence for this finding are;

- Disposition
- Number of specimen questions in the consultation
- Construction of the specimen questions
- Difference in consultation type

Disposition

There was a significant relationship between CCA- specimen questions and the disposition. There could be a number of factors influencing this; one possibility is that Nurse Advisors may approach clinical cue acquisition differently on the basis of a perceived underlying risk of each category of caller presentation, leading to an Algorithm specific approach to clinical cue acquisition. In certain presentations such as fever in a toddler, the Nurse Advisor may know, or perceive, that such a presentation is less likely to require an urgent face to face consultation with a clinician compared to other presentations such as Chest Pain or, as in the case of this study; Abdominal Pain. Nurse Advisors may be less inclined to strictly adhere to the use of the specimen questions in presentations that are unlikely to require

'Emergency' or 'Urgent' dispositions. Similarly, in presentations that are perceived to be more likely to require the caller to have a face to face clinical assessment within 4 hours, the Nurse Advisor may feel compelled to gain all responses to all specimen questions, since to miss a decision cue in this scenario is theoretically, likely to carry greater risk.

The number of specimen questions in a consultation

Alternatively, the difference in the total number of available specimen questions between the two Algorithms studied may be influential in clinical cue acquisition. The average number of specimen questions available was greater in the Fever Toddler Algorithm compared to the Abdominal Pain Algorithm. It is possible that there is a question fatigue factor relating to both the Nurse Advisor and the caller. During data collection it was noticeable that whilst some callers were content to be asked an extensive number of questions, some elicited signs of impatience, raising concerns at the length of time the consultation was taking or the sheer volume of questions being asked. The number of specimen questions available may also have an impact on the Nurse Advisors willingness to utilise them. In 40 consultations where the Fever Toddler Algorithm was used, between 40 to 46 specimen questions were available. The Nurse Advisor may be less likely to address all specimen questions in scenarios where an extensive number of them are presented within the clinical decision support software. This may be in response to performance management of call length at NHS Direct, and or in response to expressed or inferred impatience from the caller. In terms of performance management, at the time of data collection, a range of performance measures for Nurse Advisors were systematically collected and reviewed by both call centres included in the study. One of the key indicators at NHS Direct was call length and all Nurse Advisors conducting consultations within the study would have been aware that their average call length was monitored on a monthly basis. Therefore Algorithms that contained large numbers of specimen questions and were more likely to conclude in a lower urgency disposition (Routine GP or Home Care), thereby, may have a greater probability of CCA- specimen questions, as a result of the Nurse Advisor attempting to manage call length, both for the caller and their own performance management statistics. The correlation found between total available specimen questions and CCA- specimen questions lend some strength to this theory.

Construction of specimen questions

The very construction of the specimen questions may have some influence over whether they are more likely to be utilised by the Nurse Advisor. Of all the CCA- specimen questions in the study, the majority were from multiple question Topics. This raises the possibility of

multiple question Topics being utilised differently compared to single question Topics. Nurse Advisors may view multi-question Topics as a 'pick list' in contrast to single question Topics. A possible example is Topic 7 from the Fever Toddler Algorithm. During data collection, it was noted that the framing of the tense of this question differed from consultation to consultation. Some Nurse Advisors specified a timeframe such as 'within the last 24 hours' while others did not. If the Fever Toddler Algorithm contained more specimen questions that promoted varied interpretations of the past/present tense than the Abdominal Pain algorithm, this feature may be a factor in the difference between clinical cue capture between Algorithms.

Difference in consultation type

In consultations where the 'Abdominal Pain' algorithm was used, the Nurse Advisor was in direct conversation with the person experiencing the symptoms. This contrasted with 'Fever Toddler' consultations where there was a dialogue regarding the child's symptoms via a third party; the caller (parent or carer). It is possible that these different interlocution dynamics may influence clinical cue acquisition. The Nurse Advisor should always seek to acquire the relevant clinical information regardless of the barriers to obtaining such information. Nonetheless, different Nurse Advisors may vary in their approach to a third party consultation and therefore the efficacy in overcoming any third party communication difficulties may also vary.

7.3 Discussion on Clinical Risk

Multi-Question Topics

Many of the CCA- specimen questions were from multi-question Topics. This raises the question of how Nurse Advisors approach a Topic with a number of specimen questions. In the Fever Toddler Algorithm, specimen question 7.1 "Sleepy or difficult to awaken compared to usual?", may be seen as a euphemism for other specimen questions in the same Topic such as, 7.2 "More floppy (limp) than usual for him/her?" or 7.5 "Responds less to what to what is going on around him/her?". Depending on the scenario presented, these three elements may overlap in terms of clinical cues. A child may present as unusually sleepy and more floppy than usual when awake along with responding less to stimuli. In this scenario, capturing only one of these clinical cues would be unlikely to adversely affect the sensitivity and specificity of Nurse Advisor decision-making. However, in a scenario where the child is extremely tired following a particularly active day, he/she may be more sleepy than usual, but when awake, neither floppy nor responding less to stimuli. Under these circumstances

capturing only the ‘more sleepy than usual’ cue may adversely affect the specificity of Nurse Advisor decision-making, leading the Nurse Advisor to conclude that the child is more ill than they actually are, potentially resulting in a less appropriate disposition. In consultation Case #170, although elements of the ‘Symptoms of Shock’ and ‘Abdominal Trauma’ Topics were CCA- , because there were also CCA+ elements to both these Topics the likelihood of the caller suffering from either of these serious conditions was low. Even in circumstances where all elements of a multi-question Topic were CCA-, caution is required when making any judgements about clinical risk. For example, in Case #183, both the ‘Confusion Drowsiness’ Topic and the ‘Abdominal Trauma’ Topic were completely CCA-. However, given that the caller had shown no signs of cognitive impairment during the consultation to that point there would appear to be little risk of falsely assuming no confusion or drowsiness symptoms. Similarly, it is also unlikely that a caller with abdominal pain would not mention a considerable trauma such as a fall, crushing injury or blow from a blunt object if any of these events had taken place. In both the above cases it was other factors combined with these features that prompted the decision to refer them to the call centre supervisor for further review. The ‘Confusion, Drowsiness’ Topic is worthy of further consideration here since three of the ten most frequent CCA- specimen questions in consultations where the Abdominal Pain Algorithm was used were from this Topic. In all of these instances, the Nurse Advisor had been speaking to the caller for several minutes and the caller had at this point responded to several questions. Clearly, the caller could not have been unconscious during the consultation. However, it is possible that the caller could have experienced a brief episode of unconsciousness (fainting) at some point prior to the consultation. Also, in such circumstances the caller may not have associated previous fainting with the abdominal pain symptom or may have believed that the fainting episode was the result of some other causative factor, such as an excessively high ambient temperature. Neither of these scenarios are likely, but since levels of consciousness in the preceding hours to the call were not established at any point in the consultation, a false positive assumption was at least possible. Some Nurse Advisors explored this possibility while others did not. Therefore, the specimen questions in this Topic were utilised by Nurse Advisors in an inconsistent manner, but the clinical risk associated with this feature would need to be assessed on an individual consultation basis.

Among the most frequent CCA- specimen questions were those from the ‘Possible Abdominal Aortic Aneurysm’ Topic. None of the Abdominal Pain consultations studied resulted in all specimen questions from this Topic being CCA-; there was always one or more element(s) to the Topic that had been established. The first three specimen questions in this Topic addressed the onset, type and location of the pain, while the last two addressed

neurological and circulatory deficit. These are discrete clinical cues which each add definition to the clinical picture (see section 4.8 p.37). However, while some Nurse Advisors obtained all the relevant clinical cues from this Topic, others did not. It is possible with multi-question Topics that there is a critical mass of clinical information gained by asking a proportion of the specimen questions which render the remaining questions clinically redundant. If it has been established that the onset of pain was gradual, the severity of pain is mild and there has not been any neurological deficit in the lower limbs, the presence of an abdominal aortic aneurysm at that point is improbable. Under these circumstances, is there any value in establishing the two outstanding clinical cues? However, a logical pattern of considered specimen question selection did not seem apparent. Often the first specimen question of the 'Possible Abdominal Aortic Aneurysm' Topic was addressed, however in 12 consultations the first specimen question was CCA- (severity of pain the caller was experiencing). The absence of severe pain may have been assumed from the caller's voice, or the lack of any noises that would be associated with agony, such as groaning or laboured, uneven breathing. But if that was the case in these consultations, why in other consultations, faced by very similar background cues from the caller did the Nurse Advisor choose to ask the caller to describe the severity of pain. This may be due to varying risk perceptions and tolerances between Nurse Advisors, with some considering the clinical risk negligent or acceptable given the other cues acquired from the other elements of the Topic, while others sought confirmation of pain severity from the caller.

Perhaps the most surprising finding of the study was that 4 out the top 5, most frequent CCA- specimen questions in Fever Toddler consultations came from the 'Child Meningeal Symptoms' Topic. Surprising since meningitis outbreaks and especially any child deaths caused by meningitis usually gain a great deal of media coverage and furthermore, meningitis in children is often very difficult to recognise since presentations can be diverse. Despite the fact that meningitis is not prevalent, given the above considerations, one might expect a particularly fastidious approach to clinical cue acquisition from specimen questions residing in this Topic. However, 135 specimen questions from this Topic alone were CCA- across 121 Fever Toddler consultations. In some consultations it was clear that the Nurse Advisor considered that if the child could touch his/her chin to chest (the first specimen question in this Topic) then further questioning into meningeal symptoms was not required. While this is a good clinical indicator, establishing if there is any severe inflammation of the meninges (generally the child would become very distressed conducting this test if meningeal inflammation was apparent), the sensitivity of this test would be different depending on what stage of the disease progression it was conducted. Therefore, other specimen questions within the Topic may be usefully deployed to gain extra assurance in

judging the condition of the child. However the last two specimen questions in the Topic can be difficult to assess in a toddler.

Single Question Topics

The first 14 Topics in the Fever Toddler Algorithm were consecutive with no decision tree branches. Regardless of the caller response, the following Topic would be the same. Three consecutive single question Topics were among the 10 most frequent CCA- specimen questions in the Fever Toddler Algorithm, 9) 'Child Groin Swelling', 10) 'Care Giver Intuition', and 11) 'Child Immune Compromise'. If the caller response to any of these questions was yes, the NHS CAS recommendation was that the carer should seek a GP assessment for the child within 2 hours. Therefore a false negative assumption for any of these clinical cues would carry a risk of delay to definitive treatment. Why in 12 consultations the Nurse Advisor did not establish if the child had a swelling in the groin is unknown. It is important to note that although this specimen question was CCA- in 12 consultations, it was CCA+ in 109 consultations. Therefore a carer calling NHS Direct regarding a child with a fever is far more likely to have the possibility of this symptom explored than not

Paraphrasing and Miss-Phrasing

Furthermore, if a particular specimen question, in the experience of a Nurse Advisor often requires extensive paraphrasing in order that the caller understands fully what is being asked; that question may have a greater likelihood of being bypassed by the Nurses Advisor or paraphrased to such an extent that the question posed yields a different clinical cue from the one intended to be elicited by the specimen question. Specimen questions 4.3 (*Intense Headache?)* and 4.4 (*Mental confusion or difficult to rouse?)* were the two most frequent CCA- questions from the Fever Toddler Algorithm.

This raises the issue of skilled paraphrasing of specimen questions. A toddler is unlikely to verbally express that they have a severe headache. A Nurse Advisor who has knowledge and/or experience of young children's behaviour when suffering from a headache may rephrase the question, asking for example, "Is the child distressed and holding his/her head"? Similarly, instead of asking the final question in the Topic regarding mental confusion and whether the child can be roused, the question could be rephrased to ask "Is the child behaving differently, can the child be woken up as usual and when awake, is the child taking notice of things happening around him/her"? Two further specimen questions from the Fever Toddler Algorithm that were frequently CCA- and highlight the potential

variance in clinical cue acquisition due to paraphrasing are;

7.3 Crying differently to normal, e.g. persistent weak, moaning, high pitched cry?

7.4 a) Irritable for over 4 hours,

b) not calm when held, rocked or cuddled:

However, these two specimen questions, 'Crying differently to normal' and 'Irritable for over 4 hours', may be valued differently as clinical cues by Nurse Advisors with different qualification and experience profiles. The other three elements to this Topic could easily be asked of an adult subject; however the two specimen questions with high CCA- frequency could only be applied to a child. One possible explanation is that Nurse Advisors who have no paediatric nursing experience may be more inclined to ask specimen questions that could apply to an adult rather than a child, thereby facilitating the processing of familiar responses to be matched or categorised with a range of familiar meanings. Nurse Advisors without paediatric nursing experience may not have the reference points to, a) confidently paraphrase the question and b) process responses to child specific specimen questions. This may lead Nurse Advisors who are inexperienced in caring for a child, either in the professional and/or domestic setting to use child specific questions less frequently. Neither the qualifications and experience of Nurse Advisors nor the extent of paraphrasing or miss-phrasing specimen questions was collected in this study, but future research may usefully explore both the relationship between clinical cue acquisition and Nurse Advisor experience along with the ability to paraphrase specimen questions.

Grammar

The grammar of the specimen question may also have a part to play here. For example specimen question 5 in the Fever Toddler Algorithm (Has there been any bile stained vomiting [green colour, not yellow]). The symptom described in the question is very specific and unambiguous however, the tense is potentially problematic. In the specimen question the word 'been' is the past participle of the verb 'be', but as constructed in the sentence, being preceded by the auxiliary verb 'has', the tense is transformed to the present perfect, which enquires if the symptom took place in the past and is it continuing. This raises a number of issues regarding interpretation. If this specimen question is delivered verbatim by the Nurse Advisor, would the Nurse and the caller have a shared understanding of the tense? If the Nurse Advisor paraphrases the question, would the tense be preserved? Furthermore, the timeframe extending into the past is not specified by the specimen question. Clearly it would not be relevant to ask if the child had ever had this symptom but is

the last 4, 6 or 12 hours clinically relevant or would the timeframe reasonably extend to 48 hours? In the absence of an indicated timeframe, the time period represented by this question is open to Nurse Advisor interpretation, and where no timeframe was clarified by the Nurse Advisor, it would then be open to caller interpretation. In this example, clinical risk would appear low, since it is unlikely that the caller would answer negatively if the child was vomiting green bile at the time the question was asked or; if the child had vomited green bile within the last 24-48 hours. However, the level of clinical risk may vary depending on the presentation, the Algorithm used, knowledge and skills of the Nurse Advisor and the cognitive abilities of the caller.

Cue Acquisition and Disposition

The correlation between CCA- specimen questions and the disposition is likely to be a multi-factorial relationship. There were higher frequencies of CCA- specimen questions in lengthier consultations that had greater numbers of available specimen questions. One possible explanation is that the Nurse Advisor may be less inclined to capture all clinical cues associated with specimen questions in consultations where the presentation is either known or perceived to be less likely to require an 'Emergency' or 'GP 2 Hours' disposition. However, if this is the case, the risk balance of Algorithms that have an associated high CCA- profile would require further attention. Each individual consultation would have its own particular risk profile but at the generalised level of scrutiny, Algorithms with a high CCA- profile could theoretically deliver poor disposition specificity (the risk of false negatives assumptions); where the Nurse Advisor decides that the appropriate disposition is for example, 'Home Care' advice when in fact a face to face clinical assessment is required. It is important to note here that this theory rests upon the premise that CCA+ consultations yield superior decision-making specificity. This is a sensible assumption, since greater cue acquisition forms a more complete clinical picture which can then more extensively inform judgement and decision-making. However, the sensitivity and specificity of decision-making in NHS Direct consultations is also likely to be multi-factorial and the extent to which clinical cue acquisition influences decision-making in this context has yet to be established.

An example of the importance of considering any false negative assumptions alongside the disposition is Case # 170. In this consultation a number of the CCA- specimen questions were from of multi-question Topics where other elements of the Topic had been established, therefore presenting a lower risk of a false negative assumption. Although it was established that the caller was not suffering from vomiting blood, it was not confirmed if there was any malaena (blood in the stools). Malaena may not be recognised for what it is by the layperson as in this circumstance the blood is altered by its passage through the bowel and

manifests as a black tar coloured stool. Therefore of all the CCA- specimen questions in this consultation, the failure to confirm whether there had been any blood in the stool may well carry the greater risk associated with a false negative assumption. The risk of a false negative assumption infers clinical risk. However, it should be noted that these are not interchangeable terms as clinical risk is broader in its scope and would encompass other elements of the decision-making process beyond clinical cue capture. One important aspect of clinical risk would include the disposition itself. Since Case #170 concluded with a 'Home Care' disposition then clinical risk derived from low clinical cue acquisition may be greater since there has been no advice given directing the caller to see a clinician within any timescale. In Case #183 the caller was advised to gain a routine appointment with a GP; although this also carries some risk if a false negative assumption caused delay to definitive treatment.

Following the reasoning stated above, namely risk of a false negative assumption in conjunction with risk of delay to definitive treatment; two Fever Toddler consultations were particularly noteworthy. In Case #31, the key clinical cue omissions were that 3 out of the 4 'Meningeal Symptoms' Topic elements were CCA-, 4 of the 5 'Toddler Cortical Neurological Symptoms' Topic elements were CCA- and it was not established if the child was immune compromised. It was considered that these CCA- specimen questions combined with the consultation disposition of 'Home Care' constituted an elevated clinical risk, since the Nurse Advisor did not direct the caller to see a clinician within any timescale. For these reasons this call was referred to the appropriate NHS Direct Supervisor for further review. In Case #176 the key clinical cue omissions were that 2 out of the 4 'Meningeal Symptoms' Topic specimen questions were CCA-, 3 of the 5 'Toddler Cortical Neurological Symptoms' Topic elements were CCA-, and neither 'Care Giver Intuition' or the 'Not Tolerating Normal Fluids' Topics were established. Again, because of the risk of a false negative assumption combined with a disposition ('Home Care') which did not direct the caller to seek a face to face clinical assessment, this call was referred to the appropriate NHS Direct Supervisor for further review.

7.4 Ten Most Frequent CCA- Specimen Questions – Abdominal Pain

In the abdominal Pain Algorithm the two consultations which had 8 CCA- specimen questions were both referred to the relevant call centre supervisor for further review. These two consultations highlight the inviting but problematic issue of presenting clinical cue acquisition as a percentage (number of CCA- specimen questions ÷ total number of specimen questions available in the consultation). Prior to the analysis for this study it was considered that percentage figures for clinical cue acquisition could distort analysis. These

two cases illustrate how this could happen and justify the reasons for using the raw numbers of CCA- specimen questions in preference to a percentage figure. Case #170 contained 29 available specimen questions therefore 27.5% (8/29) were CCA-. Case# 183 contained 14 available specimen questions therefore 57.1% (8/14) CCA-. This encourages the assumption that Case #183 has achieved less than half the clinical cue acquisition achieved in Case #170. By using the raw numbers rather than percentages, more reliable comparisons of clinical cue acquisition could be made. This highlights some of the complexities of assessing and comparing risk between consultations.

7.5 Ten Most Frequent CCA- Specimen Questions – Fever Toddler

In the 'Infant Respiratory Distress' Topic the 'Extreme Pallor' question was CCA- in 35 consultations. However, this specimen question was one of 5 elements to this Topic which again raises the question of the possibility of a critical mass of clinical cue acquisition from any given Topic that reduces or even obviates the need to address all elements. Similarly, the 'Toddler Cortical Neurological Symptoms' Topic has 5 elements, 2 of which were among the 10 most frequent CCA- specimen questions in Fever Toddler consultations.

8. Limitations

By adopting a purely statistical approach to examining differences in clinical cue acquisition a large number of potentially relevant variables, more amenable to a qualitative approach could not be addressed. Factors such as the Nurse Advisor's attitude to clinical risk, attitude to using a CDSS, or response to performance management, could not be assessed although may be influential factors in clinical cue acquisition. The previous knowledge and experience of the nurse advisor were two other variables that could not be included in this study. An across methods exploration of these qualitative and quantitative measures could shed further light on the reasons why specimen questions were CCA- and why clinical cue acquisition varied by Algorithm and disposition.

The deconstruction of specimen questions into discrete parts which referred to discrete clinical cues was a critical determinant for data collection, analysis. This was devised by a small expert panel and while every effort was made to be consistent in the construction and application of the criteria, it is recognised that a different expert panel may have deconstructed the questions differently, potentially leading to different results.

The logic and simplicity of the definition of a CCA- specimen question was a strength in maintaining reliability of data classification. However, the very simplicity of this definition imposed certain limitations. This was most apparent in specimen questions that were part of the 'Confusion, Drowsiness' Topic. The definition of a CCA- question was that there was no explicit evidence during the consultation that the clinical cue associated with the specimen question had been expressed by the caller, either directly in the form of a verbal response or indirectly as a result of information gained from the audible background activity in the call. In the case of the three 'Confusion, Drowsiness' specimen questions, wherever these were CCA-; the caller had answered several questions preceding this point in the consultation and was evidently not unconscious and not overtly confused. One could argue that if these questions were not addressed by the Nurse Advisor that the specimen questions should be classified as CCA+ since there is explicit evidence that none of these symptoms apply. However, these were classified as CCA- because it would be clinically relevant to establish if there had been any loss of consciousness or confusion in the several hours preceding the call and not just at that present moment. A more sophisticated classification that incorporated an assessment of the caller's patterns of speech, for instance; response delays, rate of speech, cogency of responses, may have been a useful refinement to CCA- classification. Other specimen questions may have benefitted from a more reasoned flexible

approach to classification although; this may have undermined study reliability as similar characteristics may have led to subjective and inconsistent classifications.

The study has no reliable benchmark with which to gauge clinical cue acquisition. Therefore the 91.66% of all specified clinical cues acquired in this study may be upper or lower percentile performance in this field; we have no measure of comparison available.

Because of the labour intensive data collection for this study and the prohibitive logistics of travelling to various call centres; a limit of 250 consultations were studied across two algorithms and two call centres. Although this sample size achieved adequate power for the tests conducted, having only two types of algorithm and two call centres included in the study presents the risk that one of these algorithms or call centres, could have anomalous characteristics thereby undermining the validity of the research. The likelihood of this is issue is reduced for the reasons stated below.

1. Difference in consultation dynamics between adult and child presentations

Specimen questions are constructed similarly across all algorithms. The difference in communication dynamics between the algorithms studied; 'Abdominal Pain' consultations were conducted in direct conversation with the person suffering from symptoms whereas 'Fever Toddler' consultations were conducted through a third party; the caller (parent or carer). This difference does not represent a confounding variable which undermines the validity or reliability of this study; since the aim of the research was to determine if clinical cue acquisition differed by certain key independent variables. The reasons for such differences were for discussion, not determination in this study.

2. Difference in call centres

Since the results indicate there is no statistically significant difference in clinical cue acquisition by the call centres included in this study the concern here would be that both sites are unusual or unrepresentative of the service as a whole.

Although both these possibilities are unlikely, a larger study involving several NHS Direct call centres and a greater number of most frequently used algorithms, would yield improved power and precision and greater assurance of validity and reliability.

9. Conclusion

One of the main advantages of the use of algorithms in clinical decision-making is reported to be consistency of assessment judgement and outcome for the patient. At NHS Direct, the CDSS (NHS CAS) holds the promise of effectively providing a clinical cue template for any presentation, via algorithms that display specimen questions. By using the specimen questions consistently, a key element to decision-making (cue acquisition) could be made more consistent and result in a comprehensive portfolio of information upon which to exercise judgement and decision-making. It is therefore reasonable to extend the hypothesis that consistent and comprehensive cue acquisition in telephone consultations could improve consistency in outcome. This study set out to test the null hypotheses that an algorithm based CDSS delivers consistency in clinical cue acquisition. If it was determined that this was not the case, the platform upon which NHS CAS and algorithm supported clinical decision-making has rested; namely safety and consistency would need to be reassessed; or at least investigated further. Even greater credence would be afforded to this assertion if cue acquisition is correlated with the consultation outcome (the decision).

The results of this study indicate that clinical cue acquisition is significantly different by algorithm and disposition at NHS Direct. The implication of this finding is that callers to the NHS Direct service can expect a different level of clinical cue acquisition depending on what symptoms they are calling about and what disposition the Nurse Advisor decides upon. We can therefore conclude that an algorithm based CDSS, with specimen questions does not yield perfect consistency in clinical cue acquisition. Furthermore, this study determined that there is a relationship between CCA- specimen questions and the disposition. The overarching question arising from these results is; do such differences impact on the clinical safety of consultations at NHS Direct? The detailed analysis of clinical cue acquisition by specimen question offers some insights into the complexities of addressing this enquiry. Not all CCA- specimen questions could be ascribed the same predetermined clinical risk simply on the basis that the particular clinical cue in question was not captured at any point during the consultation. Each individual instance of a CCA- specimen question would need to be considered separately, taking into account all other clinical cues acquired or not acquired within the consultation; since the acquisition of one particular clinical cue may reduce the risk of a false negative assumption in another CCA- specimen question.

Despite the limitations of this study, it has clearly shown that the supposed redoubt of an algorithm based CDSS, safety through consistent use of algorithms is a questionable claim. It could be argued that systems like NHS CAS clearly offer the potential to gain enhanced clinical safety in the field of telephone consultation but the potential is currently not being realised due to inconsistent use by the system users; in the case of NHS Direct, Nurse Advisors. However, this study has highlighted that greater refinement of algorithm based CDSS may be required before this potential can be realised. Refinements to the way specimen questions are presented to the system user or the introduction of evidence based statistical inference in order to present sensitivity and specificity statistics.

The reasons for variance in clinical cue acquisition when using a CDSS such as NHS CAS are no doubt multifactorial, but unless the reasons for this variance are understood, Algorithm based CDSS in the clinical setting is unlikely to advance further.

10. Recommendations

A regular audit of clinical cue acquisition at NHS Direct using the methodology described in this study would be useful in identifying which specimen questions from which algorithms have a high CCA- frequency. An audit of this nature would be labour intensive, but efficiency could be greatly improved by using cluster sampling and involving a number of personnel in the data collection process. Clearly not all Algorithms or all NHS Direct sites could be included in any single audit, so a rolling programme of auditing would be required. This would give NHS Direct an overview of specimen question use and could inform subsequent focus on why these specimen questions are so frequently CCA-. This could lead to improved construction of specimen questions in NHS CAS and an informed, systematic approach to consultation review. Although at the time of this study, consultation review was firmly embedded in the culture of NHS Direct, and a standardised review proforma was in place. Judgements of clinical cue acquisition, clinical risk and the remedial actions that may be required subsequent to review findings were not housed within a common framework or approach. Also, any statistics generated were not systematically analysed except for measures of central tendency which were used predominantly for deriving performance management tolerances. A systematic audit of CCA- variance by NHS Direct call centre, Algorithm and disposition would provide some focus for reliable, generalised risk assessment of clinical cue acquisition.

The results of this study raise questions of clinical safety in NHS Direct consultations. It is not clear from these results the extent to which a CCA- specimen question and therefore any possible false assumptions drawn from it represent clinical risk. A CCA- specimen question may infer risk but many other factors must be taken into consideration which making a reasoned assessment of clinical risk. It was apparent through this study that key detailed and evidence based reference points which the dependant variable could triangulate with in order to refine judgement on clinical risk were not available. Decision-making sensitivity and specificity generally at NHS Direct is unknown and the relative risk of a Nurse Advisor failing to address any given specimen question is also unknown. The former endeavour would no doubt be costly and may require a lengthy timeline to achieve. However, it may be useful in future studies to calculate the relative risk of CCA- specimen questions by disease or prevalence. For example; the ‘Child Groin Swelling’ specimen question being CCA- in an NHS Direct consultation, divided by the risk of childhood inflammatory conditions of the groin in the general population. In this way, specimen questions could be weighted by relative risk which could provide a useful benchmark for assessing clinical risk. However, this approach could not be applied to all specimen questions within NHS CAS. The ‘Care Giver Intuition’

Topic is an example of the limitations of such a method. In this circumstance, the sensitivity and specificity of care giver intuition would be required; an endeavour which would be marked by many confounding variables relating to the care giver such as cognitive abilities, care giving experience and relationship to the child. Nonetheless, information regarding prevalence of diseases is increasing and therefore some key questions from some of the most frequently used Algorithms could be calculated in terms of the relative risk of a CCA-specimen question presents. This could pave the way to the development of a more sophisticated Clinical Decision Support Software which uses Monte Carlo probabalistic algorithms to highlight key specimen questions that must be addressed by the Nurse Advisor in order to preserve an acceptable risk profile for the consultation. No doubt this would be highly controversial since it would prompt a revision of the knowledge and skills required to conduct the decision supported consultation, but it may hold the key to more consistent and appropriate use of specimen questions.

The culture and performance management approach at NHS Direct would also prove worthy of research in terms of the influence they may have on how a Nurse Advisor conducts a consultation. The directive approach of Nurse Advisors at the Milton Keynes call centre contrasted with the more discursive approach in consultations at the Dudley call centre. Although in this study, clinical cue acquisition did not differ significantly by NHS Direct call centre, a wider study, incorporating many NHS Direct call centres would be of value to explore the affects of performance management drives on the judgement and decision-making of Nurse Advisors.

A specific research study to explore the affects of specimen question grammar at NHS Direct would be extremely useful, not only in terms of clinical safety, but also to inform specimen question modification and/or development. During the data collection phase of this study it was apparent that in the absence of a defined period of the past tense within the specimen question, Nurse Advisors were inconsistent in defining the timeframe. A study which focused on not only tense but other grammatical aspects of specimen questions such as conjunctions and prepositions may discover hitherto unsuspected relationships between the grammatical construction of the specimen question and clinical cue acquisition.

A clinical cue acquisition benchmark would facilitate comparisons not only within NHS Direct but across other healthcare telephone-consultation services. It would also provide very useful data on the cue acquisition differences between various clinical decision support software.

11. References

Alexander,G.L., 2006. Issues of trust and ethics in computerized clinical decision support systems. *Nursing Administration Quarterly*, 30 (1) pp.21-29

Atkinson, R., Shiffrin, R., 1968. Human memory: A proposed system and its control processes. In: ed. Spence, K., & Spence, J., 1968 *The psychology of learning and motivation:* Advances in research and theory. New York: New York: Academic Press.

Barnett, G.O., Cimino, J.J., Hupp, J.A., Hoffer, E.P., 1987. DXplain: An Evolving Diagnostic Decision Support System. Journal of the American Medical Association , 258, (1), pp.67-74.

Barnett, G.O., Famiglietti, K.T., Kim, R.J., Hoffer, E.P. Feldman, M.J., Mitchell, J.,

1998. DXplain on the Internet. *Harvard Medical School,* [online] Available at: <http://home.smh.com/sections/servicesprocedures/medlib/subjects/Infobuttons/infobutton_DXplain_.pdf > [Accessed 18 June 2009]

Boden, M.A., 2006. *Mind as Machine – A History of Cognitive Science*. Oxford: Oxford University Press.

British Telecommunications, 2007. Virtual Contact Centre strategy improves patient services at reduced cost. [online] Available at: <http://globalservices.bt.com/static/assets/pdf/case> [Accessed 14June, 2009]

Buchanan, B., Shortliffe, E., 1984. *Rule Based Expert Systems: The Mycin Experiments of the Stanford Heuristic Programming Project* . Boston, Massachusetts: Addison-Welsley.

Buckingham, C.D., Adams, A., 2000. Classifying clinical decision making: a unifying approach. *Journal of Advanced Nursing*, Volume 32(4) pp. 981-989.

Carnevalli, D. L., Mitchell, P. H., Woods, N. F., & Tanner, C. A. (1984). *Diagnostic Reasoning in Nursing*. Philadelphia: Lippincot.

Chomsky, N. 1963. *Formal properties of grammars. Handbook of Mathematical Psychology*. In: eds. Luce, R.D., Bush, R.R., Galanter, E., Oxford: John Wiley and Sons.

Crouch, R., 2002. Computerised Decision Support. In: ed. Thompson, C. Dowding, D. 2002. *Clinical Decision Making and Judgement in Nursing.* Oxford: Churchill Livingstone.

Cunningham, P., Green, L., Miles,I., Rigby, J., 2005. NHS Direct: An Innovation in Social Trust. Publin Report No. D12-3.

Davis, R., Buchanan, B., Shortliffe, E., 1977. Production Rules as a Representation for a Knowledge-Based Consultation Program. *Artificial Intelligence,* 8 (1), pp.15-45.

De Dombal, F.T., Leaper, D.J., Staniland, J.R., McCann, A.P., Horrocks, J.C., 1972. Computer aided diagnosis of acute abdominal pain. *British Medical Journal* [online] Available at: <http://www.bmj.com/highwire/filestream/230872/field_highwire_article_pdf/0.pdf > [Accessed 19 July 2009]

Department of Health, 1997. A New NHS, Modern – Dependable. *Department of Health* [online] Available at: <http://www.archive.officialdocuments.co.uk/document/doh/newnhs/contents.htm> [Accessed 5 July 2009]

Department of Health, 2000. The NHS Plan: A plan for investment, a plan for reform, Department of Health, [online] Available at: <http://www.dh.gov.uk/dr_consum_dh/groups/dh_digitalassets/@dh/@en/@ps/documents/digitalasset/dh_118522.pdf> [Accessed 5 July 2009]

Dowding, D., Mitchell, N., Randell, R., Foster, R., Lattimer, V., Thompson, C., 2009. Nurses' use of computerised clinical decision support systems: a case site analysis. *Journal of Clinical Nursing*, 18 (8), pp. 1159-1167.

Dreyfus, H., Dreyfus. S., 1986. *Mind Over Machine: The Power of Human Intuition and Expertise in the Era of the Computer*. Oxford: Basil Blackwell.

Duffin, C., 2008, NHS Direct drops Foundation Trust plans. *Health Service Journal* [online] Available at: <http://www.hsj.co.uk/nhs-direct-drops-foundation-trust-plans/1916986.article > [Accessed 12 August 2009]

Elstein, A.S., Schulman, L.S., Sprafka, S.A., 1978. *Medical problem solving: an analysis of Clinical reasoning*. London: Harvard University Press.

Farrand, L., Leprohon, J., Kalina, M., Champagne, F., Contandriopoulus, A.P., Preker, A. 1995. The role of protocols and professional judgement in emergency medical dispatching. *European Journal of Emergency Medicine*, September (3) pp.136-148.

Florrin, D., Rosen, R., 1999. Evaluating NHS Direct: Early findings raise questions about expanding the service. *British Medical Journal,* 319, pp. 5-6

Garg, A.X., Adhikari, N.K.J., McDonnald, H., Rosas-Arellano, P.M., Devereaux. P.J., Beyene, J., Sam, J., Haynes, B., 2005. Effects of Computerized Clinical Decision Support Systems on Practitioner Performance and Patient Outcomes: A Systematic Review. JAMA, 293 (9), pp.1223-1238.

Gilovich, T., Griffin,D., Kahneman, D., 2002. Heuristics and Biases: The psychology of intuitive judgement. Cambridge: Cambridge University Press.

Grant, C., Nicholas, R., Moore, L., Salisbury, C., 2002. An observational study comparing quality of care in walk-in centres with general practice and NHS Direct using standardised patients. *British Medical Journal* [online] Available at: <http://www.bmj.com/highwire/filestream/365467/field_highwire_article_pdf/0.pdf> [Accessed 28 July 2009].

Hammersley, J.M., Handscomb, D.C., 1997. *Monte Carlo Methods*. London: Methuen.

Hammond, K.R., McClelland, G.H., Mumpower, J., 1980. Human Judgement and Decision Making. New York: Praeger.

Hazard-Munro, B., 2001. *Statistical Methods for health Care Research*. 4rth ed. Ney York: Lippincott.

Kong, G., XU, D.L., Bo-Yang, A.J., 2008. Clinical Decision Support Software: A review on knowledge representation and inference under uncertainties. *International Journal of Computational Intelligence Systems,* 1 (2) pp.159-167.

Lambell, P., Cooper, A. Hoyles, S., Pygall, S.A., O'Cathain, A., 2003 An audit of paediatric fever in NHS Direct: Consistency of advice by nurses using computerised decision support software systems. *British Journal of Clinical Governance,* 8(3) pp. 222-226.

Mayo, A.M., Chang, B.L., Omery, A., 2002. Use of Protocols and Guidelines by Telephone Nurses. Clinical Nursing Research, 11(2), pp.204-219.

McCarthy, J.L., 1984. We Need Better Standards for Artificial Intelligence Research: President's Message. *AI Magazine,* 5 (3) pp.7-8.

McInerney, J., Chillala, S., Read, C., Evans, A., 2000. Impact of NHS Direct on demand for immediate care*. British Medical Journal*, 321, pp. 1077.

Monoghan, R., Clifford, C., McDonald, P., 2003. Seeking advice from NHS direct on common childhood complaints:does it matter who answers the phone? *Journal of Advanced Nursing*, 42(2), 209–216.

Morrell, CJ., Munro, J., O'Cathain, A., Warren, K., Nicholl, J., 2002. Impact of NHS Direct on other services: the characteristics and origins of its nurses*. Emergency Medicine,* 19, pp. 337–340.

Munro, J., Nicholl, J., O'Cathain, A., Knowles, E., 2000. Impact of NHS Direct on demand for immediate care: an observational study*. British Medical Journal*, 321, pp.150–3.

Munro, J., Nicholl, J., O'Cathain, A., Knowles, E., Morgan, A., 2001. Evaluation of NHS Direct First Wave Sites: Final report of the phase 1 research. [pdf] Sheffield: Sheffield - Medical Care Research Unit. Available at: <http://www.shef.ac.uk/polopoly_fs/1.44080!/file/MCRU-nhsd3-2001.pdf> [Accessed 5 August 2009].

Munro, J., Sampson, F., Nicholl, J., (2005). The impact of NHS Direct for Out of Hours primary and emergency care. *British Journal of General Practice*, 55,(519), pp.790-792.

National Audit Office, 2002. *NHS Direct in England.* London: National Audit Office

NHS Direct, 2008. Annual Report & Accounts 2007/08. The Stationary Office.

NHS Direct, 2009. History, [Online] Available at: <http://www.nhsdirect.nhs.uk/About/History> [Accessed 16 May 2009]

O´Cathain, A., Munro. J., Armstrong. I., O´Donnell. C., Heaney. D., 2007. The effect of attitude to risk on decisions made by nurses using computerised decision support

software in telephone clinical assessment: an observational study. *Biomed Central Medical Informatics and Decision-making*, [online] Available at: < http://eprints.gla.ac.uk/4032/1/ODonnell4032.pdf> [Accessed 19 July 2009]

O'Cathain, A., Webber, E., Nicholl, J., Munro, J., Knowles, E., 2003. NHS Direct: Consistency of triage outcomes. *Emergency Medical Journal,* 20, pp. 289-292.

Purcell, G.P., 2005. What makes a good clinical decision support system: We have some answers, but implementing good decision support is still hard*. British Medical Journal*, 330, pp.740-741.

Richards, D.A., 2004. NHS Direct Versus General Practice Based Triage for Same Day Appointments in Primary Care: Cluster Randomised Controlled Trial*. British Medical Journal*, [online] Available at:

< http://www.bmj.com/highwire/filestream/390660/field_highwire_article_pdf/0.pdf> [Accessed 5 August 2009].

Rumelhart, D., McClelland, J., 1986. *Parallel Distributed Processing*. vol. I, Cambridge, Mass.: MIT Press.

Rustan, A., 2006. Interpreting and managing risk in a machine bureaucracy: Professional decision-making in NHS Direct. *Health, Risk & Society,* 8 (3), pp. 257-271.

Seigel, S. Castellan, N J., (1998) Non Parametric Statistics for the Behavioural Sciences. Toronto: Magraw-Hill.

Shortliffe, E.H., 1976. *Computer-Based Medical Consultations*: MYCIN. New York: Elsevier/North Holland.

Shortliffe, E., 1990 *Medical informatics: computer applications in health care*. Reading, MA: Addison-Welsley.

Smolensky, P., Mozer, M. C., Rumelhart, D.E. eds., (1996). *Mathematical perspectives on neural networks.* New Jersey: Erlbaum.

Stewart, B., Fairhurst, R., Markland, J., Marzouk, O., (2006). Review of calls to NHS Direct related to attendance in the paediatric emergency department*. Emergency Medical Journal*, 23, pp. 911-914.

Taylor, P., 2006. *From Patient Data to Medical Knowledge*. British Medical Journal Books, London: Blackwell Publishing

Tversky, A., Kahneman, D., 1974. Judgment under uncertainty: heuristics and biases. *Science* 185, pp.1124–1131.

UK Government, *The NHS Direct (Establishment and Constitution) Order 2004.* SI 2004/569. London: HSMO.

UK Government*, The NHS Direct (The NHS Direct Special Health Authority Abolition Order) 2007*. SI 2007/504. London: HSMO.

Wachter, D.A., Brillman, J.C., Lewis, J., Sapien, R.E. 1999. Paediatric telephone triage protocols: standardized decision-making or a false sense of security. *Annals of Emergency Medicine*, 33(4) pp.388-394.

Winter, R., Thompson, S., 2003. NHS Direct: Reducing unnecessary Harm in health care through information technology and shifting nurses roles. In: eds. Milligan,F., Robinson,K., 2003. *Limiting Harm in Health Care: A Nursing Perspective.* Oxford: Wiley - Blackwell Publishing.

12. Glossary of Terms used in this Thesis

Term	Description
Abdominal Pain algorithm	One of the many Algorithms in NHS CAS. The Abdominal Pain Algorithm is used to assess callers to the service who have abdominal pain and are aged 16 and over.
Algorithm	In the context of telephone consultation an Algorithm is a decision tree that presents different prompts depending on user input. There are various types of logic which control what is displayed - in NHS CAS there is a binary logic YES/NO which accesses different parts of a static decision tree, depending on input.
Clinical Cue Acquisition	The term used throughout this thesis to refer to clinical cue acquisition negative or clinical cue acquisition positive specimen questions.
Clinical Cue Acquisition Negative (CCA-) specimen questions	These are specimen questions where the Nurse Advisor has **not** gained the clinical cue associated with the question.
Clinical Cue Acquisition Positive (CCA+) specimen questions	These are specimen questions where the Nurse Advisor has gained the clinical cue associated with the question.
Clinical Decision Support Software (CDSS)	Often a software package that supports the user in assessing and advising others. The user will usually have access to knowledge, information gathering and decision making.
Disposition	The final advice/decision that the Nurse Advisor gives to the caller following a telephone assessment.
Fever Toddler algorithm	One of the many Algorithms in NHS CAS. The Fevder Toddler Algorithm is used to assess callers to the service who are caring for a child who has a the symptoms of a fever and is aged and 1 to 4 years old.
NHS CAS	The CDSS used throughout NHS Direct.
Telephone Consultation	The term used throughout this thesis for NHS Direct telephone assessment and advice.
NHS Direct	National telephone health advice and health information service.
Presentation	This is the symptom or range of symptoms that a caller to NHS Direct may present with.
Total Available Specimen Questions	These are the total available specimen questions within the algorithm for any particular NHS Direct consultation. Even in using the same algorithm the number of available specimen questions will vary dependant on the responses the caller make and the input into NHS CAS from the Nurse Advisor.

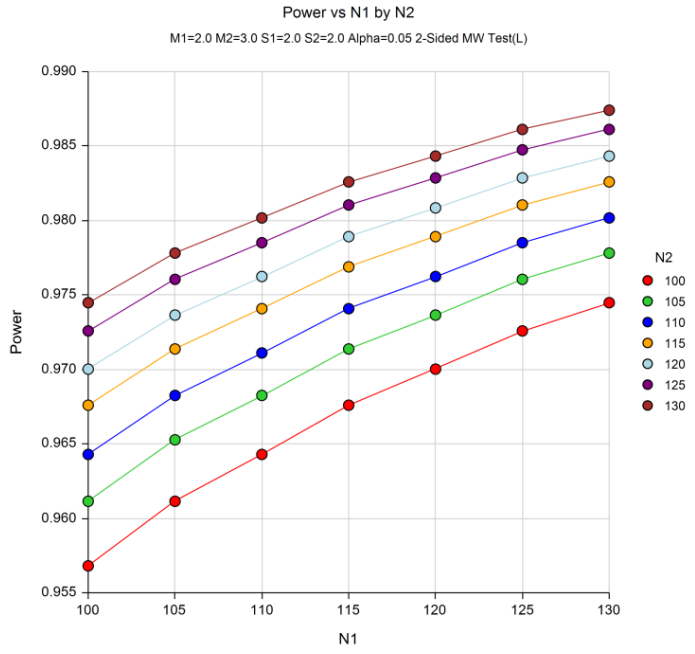
APPENDIX A1

Sample Size Estimation for Difference in Dispositions and CCA- Specimen questions. Power Analysis

Numeric Results for Mann-Whitney Test (Logistic Distribution)
Null Hypothesis: Mean1=Mean2. Alternative Hypothesis: Mean1≠Mean2
The standard deviations were assumed to be unknown and equal.

Power	N1	N2	Allocation Ratio	Alpha	Beta	Mean1	Mean2	S1	S2
0.98085	120	120	1.000	0.05000	0.01915	2.0	3.0	2.0	2.0
0.98286	120	125	1.042	0.05000	0.01714	2.0	3.0	2.0	2.0
0.98433	120	130	1.083	0.05000	0.01567	2.0	3.0	2.0	2.0
0.97259	125	100	0.800	0.05000	0.02741	2.0	3.0	2.0	2.0
0.97605	125	105	0.840	0.05000	0.02395	2.0	3.0	2.0	2.0
0.97851	125	110	0.880	0.05000	0.02149	2.0	3.0	2.0	2.0
0.98105	125	115	0.920	0.05000	0.01895	2.0	3.0	2.0	2.0
0.98286	125	120	0.960	0.05000	0.01714	2.0	3.0	2.0	2.0
0.98475	**125**	**125**	**1.000**	**0.05000**	**0.01525**	**2.0**	**3.0**	**2.0**	**2.0**
0.98612	125	130	1.040	0.05000	0.01388	2.0	3.0	2.0	2.0
0.97448	130	100	0.769	0.05000	0.02552	2.0	3.0	2.0	2.0
0.97782	130	105	0.808	0.05000	0.02218	2.0	3.0	2.0	2.0
0.98018	130	110	0.846	0.05000	0.01982	2.0	3.0	2.0	2.0
0.98260	130	115	0.885	0.05000	0.01740	2.0	3.0	2.0	2.0
0.98433	130	120	0.923	0.05000	0.01567	2.0	3.0	2.0	2.0

The highlighted figures in red show the nearest approximation of the sample size that was used in the study.



Above is a graphic representation of sample power: range of sample size per group is *n*= 100 to 130.

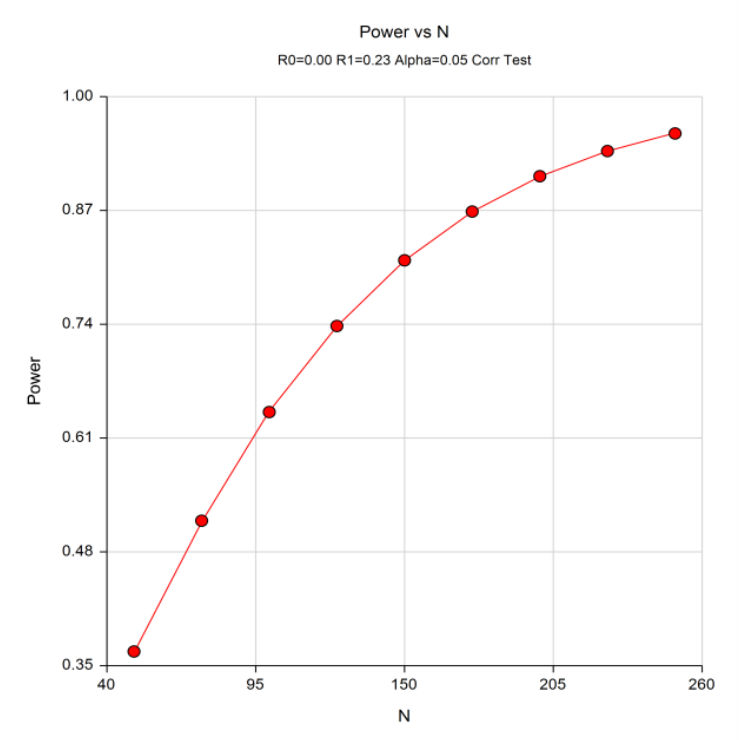
APPENDIX A1 (continued)

One Correlation Power Analysis

Numeric Results when Ha: R0<>R1

Power	N	Alpha	Beta	R0	R1
0.36621	50	0.05000	0.63379	0.00000	0.23000
0.51558	75	0.05000	0.48442	0.00000	0.23000
0.63972	100	0.05000	0.36028	0.00000	0.23000
0.73800	125	0.05000	0.26200	0.00000	0.23000
0.81304	150	0.05000	0.18696	0.00000	0.23000
0.86873	175	0.05000	0.13127	0.00000	0.23000
0.90911	200	0.05000	0.09089	0.00000	0.23000
0.93784	225	0.05000	0.06216	0.00000	0.23000
0.95796	250	0.05000	0.04204	0.00000	0.23000

A sample size of 250 achieves 96% power to detect a difference of -0.23000 between the null hypothesis correlation of 0.00000 and the alternative hypothesis correlation of 0.23000 using a two-sided hypothesis test with a significance level of 0.05000.



Above is a graphic representation of sample power: range of sample is *n*= 50 to 250

APPENDIX A2

ETHICS APPROVAL

National Research Ethics Service
NRES Committee West Midlands - Edgbaston
Prospect House
Fishing Line Road
Enfield
Redditch
B97 6EW
Telephone: 01527 582533
Facsimile: 01527 582540

Chairman: **Dr J Rao**
Administrator: **Mrs A McCullough**

Date: 01 July 2005

Mr Anthony Nicholls
Research & Development Coordinator
NHS Direct
Birmingham Black Country & Solihull
Navigation Point, Waterfront Business Park, Waterfront Way
Brierley Hill, West midlands
DY5 1LX

Dear Mr Nicholls

Full title of study: **A 12 month prospective observational study to assess how nurses utilise clinical decision support software to assess and process clinical cues in the teleconsultation setting.**
REC reference number: **05/MRE07/17**

Thank you for your letter of 15 June 2005, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised.

The Committee has designated this study as having "no local investigators". There is no requirement for [other] Local Research Ethics Committees to be informed or for site-specific assessment to be carried out at each site.

Conditions of approval

The favourable opinion is given provided that you comply with the conditions set out in the attached document. You are advised to study the conditions carefully.

APPENDIX A2

(continued)

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Application		03 February 2005
Investigator CV		03 February 2005
Protocol	1.1	03 February 2005
Covering Letter		15 June 2005
Copy of Questionnaire	1.1	03 February 2005
Participant Information Sheet	1.2	25 May 2005
Flowchart of Research Protocol	1.1	03 February 2005
Letter of support from Dr J J de Gorter		04 December 2005
Letter of support from Dr I Robertson Steel		02 November 2004
Supervisor's CV		03 February 2005

Management approval

You should arrange for all relevant NHS care organisations to be notified that the research will be taking place, and provide a copy of the REC application, the protocol and this letter.

All researchers and research collaborators who will be participating in the research must obtain management approval from the relevant care organisation before commencing any research procedures. Where a substantive contract is not held with the care organisation, it may be necessary for an honorary contract to be issued before approval for the research can be given.

Membership of the Committee

The members of the Ethics Committee who were present at the meeting are listed on the attached sheet.

Notification of other bodies

The Committee Administrator will notify the research sponsor that the study has a favourable ethical opinion.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

05/MRE07/17 Please quote this number on all correspondence

With the Committee's best wishes for the success of this project,

Yours sincerely

Dr J Rao
Chair

Enclosures: Standard approval conditions Attendance at Committee meeting on 23 March 2005 [to follow]

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APPENDIX B1

Clinical Cue Acquisition Negative Descriptive Statistics

Statistics

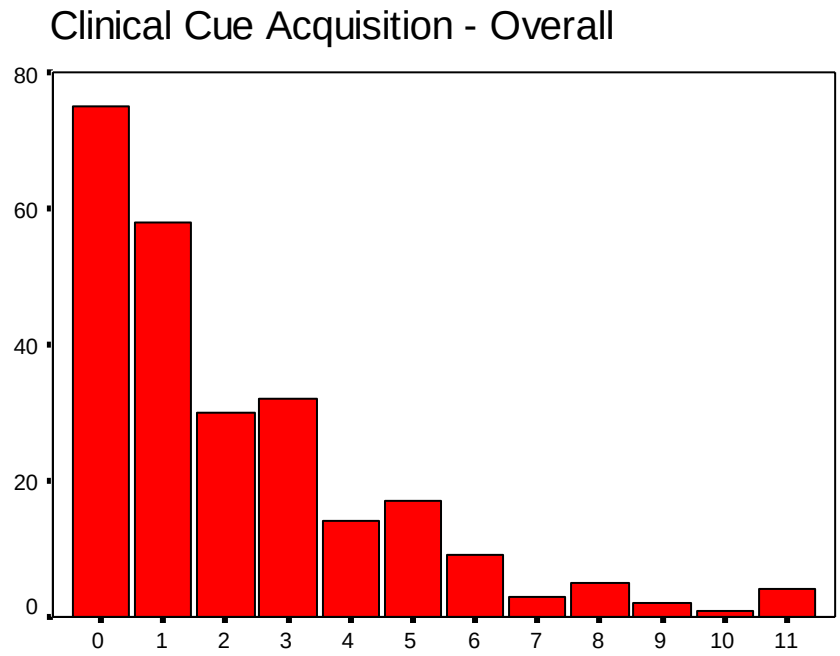
Clinical Cue Acquisition - Overall

N	Valid	250
	Missing	0
Mean		2.17
Std. Error of Mean		.154
Median		1.00
Mode		0
Std. Deviation		2.435
Variance		5.932
Skewness		1.498
Std. Error of Skewness		.154
Kurtosis		2.208
Std. Error of Kurtosis		.307
Range		11
Minimum		0
Maximum		11
Sum		542
Percentiles	25	.00
	50	1.00
	75	3.00

CCA- Specimen Questions Overall

		Frequency	Percent	Valid Percent	Cumulative Percent	Total Number CCA Specimen Questions
Valid	0	75	30	30	30	0
	1	58	23.2	23.2	53.2	58
	2	30	12	12	65.2	60
	3	32	12.8	12.8	78	96
	4	14	5.6	5.6	83.6	56
	5	17	6.8	6.8	90.4	85
	6	9	3.6	3.6	94	54
	7	3	1.2	1.2	95.2	21
	8	5	2	2	97.2	40
	9	2	0.8	0.8	98	18
	10	1	0.4	0.4	98.4	10
	11	4	1.6	1.6	100	44
	Total	250	100	100		542

APPENDIX B1 (continued)



APPENDIX B2

Total Available Specimen Questions Statistics

Statistics

Total Available Specimen Questions

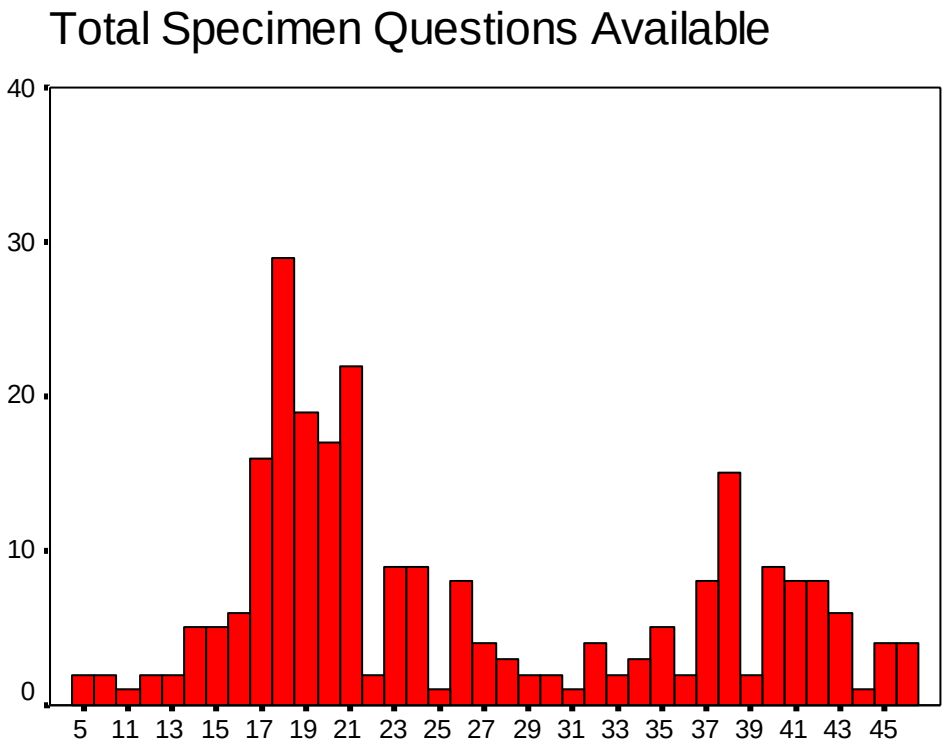
N	Valid	250
	Missing	0
Mean		26.00
Std. Error of Mean		.636
Median		21.00
Mode		18
Std. Deviation		10.058
Variance		101.161
Skewness		.486
Std. Error of Skewness		.154
Kurtosis		-1.035
Std. Error of Kurtosis		.307
Range		41
Minimum		5
Maximum		46
Sum		6501
Percentiles	25	18.00
	50	21.00
	75	37.00

APPENDIX B2 (continued)

Total Specimen Questions Available

	Specimen Questions Available	Frequency of Consultations	Percent	Valid Percent	Cumulative Percent	Total Number Specimen Questions	Cumulative Total Specimen Questions
Valid	5	2	0.8	0.8	0.8	10	10
	7	2	0.8	0.8	1.6	14	24
	11	1	0.4	0.4	2	11	35
	12	2	0.8	0.8	2.8	24	59
	13	2	0.8	0.8	3.6	26	85
	14	5	2	2	5.6	70	155
	15	5	2	2	7.6	75	230
	16	6	2.4	2.4	10	96	326
	17	16	6.4	6.4	16.4	272	598
	18	29	11.6	11.6	28	522	1120
	19	19	7.6	7.6	35.6	361	1481
	20	17	6.8	6.8	42.4	340	1821
	21	22	8.8	8.8	51.2	462	2283
	22	2	0.8	0.8	52	44	2327
	23	9	3.6	3.6	55.6	207	2534
	24	9	3.6	3.6	59.2	216	2750
	25	1	0.4	0.4	59.6	25	2775
	26	8	3.2	3.2	62.8	208	2983
	27	4	1.6	1.6	64.4	108	3091
	28	3	1.2	1.2	65.6	84	3175
	29	2	0.8	0.8	66.4	58	3233
	30	2	0.8	0.8	67.2	60	3293
	31	1	0.4	0.4	67.6	31	3324
	32	4	1.6	1.6	69.2	128	3452
	33	2	0.8	0.8	70	66	3518
	34	3	1.2	1.2	71.2	102	3620
	35	5	2	2	73.2	175	3795
	36	2	0.8	0.8	74	72	3867
	37	8	3.2	3.2	77.2	296	4163
	38	15	6	6	83.2	570	4733
	39	2	0.8	0.8	84	78	4811
	40	9	3.6	3.6	87.6	360	5171
	41	8	3.2	3.2	90.8	328	5499
	42	8	3.2	3.2	94	336	5835
	43	6	2.4	2.4	96.4	258	6093
	44	1	0.4	0.4	96.8	44	6137
	45	4	1.6	1.6	98.4	180	6317
	46	4	1.6	1.6	100	184	6501
	Total	250	100	100			

APPENDIX B2 (continued)



APPENDIX B3

Mann-Whitney Test

CCA- Specimen Questions by NHS Direct Call Centre

Ranks

	NHS Direct Call Centre	N	Mean Rank	Sum of Ranks
CCA- Specimen Questions	Dudley	128	128.36	16430.00
	Milton Keynes	122	122.50	14945.00
	Total	250		

Test Statistics(a)

	Missed Cues
Mann-Whitney U	7442.000
Wilcoxon W	14945.000
Z	-.655
Asymp. Sig. (2-tailed)	.513

a Grouping Variable: NHS Direct Call Centre

CCA- Specimen Questions by NHS Direct Call Centre

Count		NHS Direct Call Centre		Total
CCA- Specimen Questions Per Consultation		Milton Keynes	Dudley	
CCA-	0	37	38	75
	1	30	28	58
	2	16	14	30
	3	12	20	32
	4	12	2	14
	5	6	11	17
	6	4	5	9
	7	1	2	3
	8	2	3	5
	9	1	1	2
	10	0	1	1
	11	1	3	4
Total		122	128	250

APPENDIX B4

Mann-Whitney Test

CCA- Specimen Questions by Algorithm

Ranks

	Algorithm Number Code	N	Mean Rank	Sum of Ranks
CCA- Specimen Questions	Abdominal Pain	129	106.19	13699.00
	Fever Toddler	121	146.08	17676.00
	Total	250		

Test Statistics(a)

	CCA- Specimen Questions
Mann-Whitney U	5314.000
Wilcoxon W	13699.000
Z	-4.457
Asymp. Sig. (2-tailed)	.000

a Grouping Variable: Algorithm

CCA- Specimen Questions by

Count		Abdominal Pain	Fever Toddler
	CCA- Specimen Questions Per Consultation	Frequency	Frequency
Valid	0	48	27
	1	33	25
	2	21	9
	3	15	17
	4	3	11
	5	7	10
	6	0	9
	7	0	3
	8	2	3
	9	0	2
	10	0	1
	11	0	4
	Total	129	121

APPENDIX B5.1

Statistics

Total Available Specimen Questions - Abdominal Pain

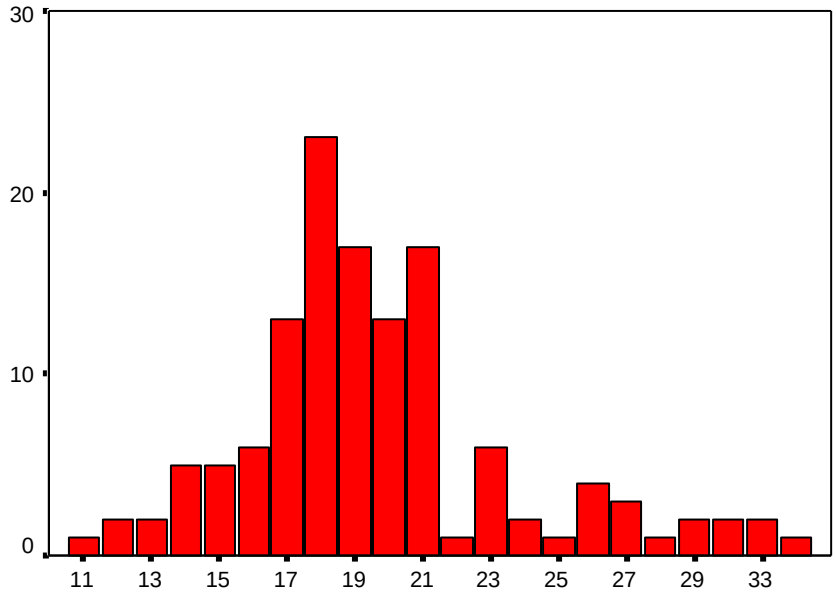
N	Valid	129
	Missing	0
Mean		19.70
Std. Error of Mean		.374
Median		19.00
Mode		18
Std. Deviation		4.244
Variance		18.009
Skewness		1.086
Std. Error of Skewness		.213
Kurtosis		1.732
Std. Error of Kurtosis		.423
Range		23
Minimum		11
Maximum		34
Percentiles	25	17.00
	50	19.00
	75	21.00

Total Available Specimen Questions - Abdominal Pain

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	11	1	.8	.8	.8
	12	2	1.6	1.6	2.3
	13	2	1.6	1.6	3.9
	14	5	3.9	3.9	7.8
	15	5	3.9	3.9	11.6
	16	6	4.7	4.7	16.3
	17	13	10.1	10.1	26.4
	18	23	17.8	17.8	44.2
	19	17	13.2	13.2	57.4
	20	13	10.1	10.1	67.4
	21	17	13.2	13.2	80.6
	22	1	.8	.8	81.4
	23	6	4.7	4.7	86.0
	24	2	1.6	1.6	87.6
	25	1	.8	.8	88.4
	26	4	3.1	3.1	91.5
	27	3	2.3	2.3	93.8
	28	1	.8	.8	94.6
	29	2	1.6	1.6	96.1
	30	2	1.6	1.6	97.7
	33	2	1.6	1.6	99.2
	34	1	.8	.8	100.0
	Total	129	100.0	100.0	

APPENDIX B5.1 (continued)

Total Available Specimen Questions – Abdominal Pain



Total Available Specimen Questions

APPENDIX B5.2

Statistics

Total Available Specimen Questions – Fever Toddler

N	Valid	121
	Missing	0
Mean		32.73
Std. Error of Mean		.920
Median		37.00
Mode		38
Std. Deviation		10.118
Variance		102.367
Skewness		-.792
Std. Error of Skewness		.220
Kurtosis		-.298
Std. Error of Kurtosis		.437
Range		41
Minimum		5
Maximum		46
Percentiles	25	24.00
	50	37.00
	75	41.00

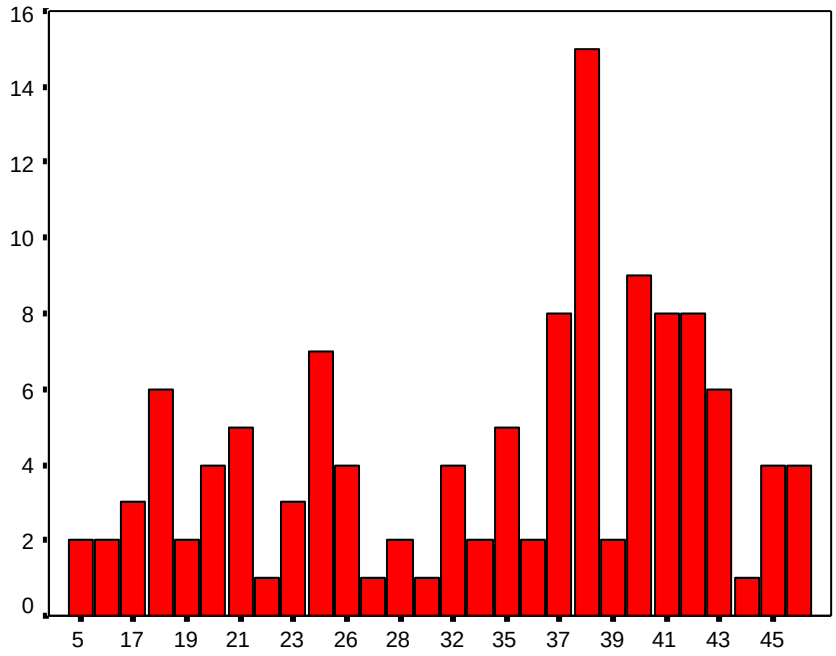
Total Available Specimen Questions – Fever Toddler

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	2	1.7	1.7	1.7
	7	2	1.7	1.7	3.3
	17	3	2.5	2.5	5.8
	18	6	5.0	5.0	10.7
	19	2	1.7	1.7	12.4
	20	4	3.3	3.3	15.7
	21	5	4.1	4.1	19.8
	22	1	.8	.8	20.7
	23	3	2.5	2.5	23.1
	24	7	5.8	5.8	28.9
	26	4	3.3	3.3	32.2
	27	1	.8	.8	33.1
	28	2	1.7	1.7	34.7
	31	1	.8	.8	35.5
	32	4	3.3	3.3	38.8
	34	2	1.7	1.7	40.5
	35	5	4.1	4.1	44.6
	36	2	1.7	1.7	46.3

APPENDIX B5.2 (continued)

37	8	6.6	6.6	52.9
38	15	12.4	12.4	65.3
39	2	1.7	1.7	66.9
40	9	7.4	7.4	74.4
41	8	6.6	6.6	81.0
42	8	6.6	6.6	87.6
43	6	5.0	5.0	92.6
44	1	.8	.8	93.4
45	4	3.3	3.3	96.7
46	4	3.3	3.3	100.0
Total	121	100.0	100.0	

Total Available Specimen Questions – Toddler Fever



Total Available Specimen Questions

APPENDIX B6

Correlations CCA- Specimen Questions and Disposition

Spearman's rho		CCA-Specimen Questions	Disposition
CCA-Specimen Questions	Correlation Coefficient	1.000	.230(**)
	Sig. (2-tailed)	.	.000
	N	250	250
Disposition	Correlation Coefficient	.230(**)	1.000
	Sig. (2-tailed)	.000	.
	N	250	250

** Correlation is significant at the 0.01 level (2-tailed).

CCA- Specimen Questions * Disposition Cross-tabulation

Count		Disposition					Total
		Emergency	GP 2 Hrs	GP Same Day	Routine GP or Health Professional	Home Care	
CCA-Specimen Questions per Consultation	0	10	15	30	6	14	75
	1	2	13	25	7	11	58
	2	2	10	7	7	4	30
	3	0	12	8	4	8	32
	4	1	3	4	1	5	14
	5	0	1	4	4	8	17
	6	0	1	2	0	6	9
	7	0	1	1	0	1	3
	8	0	0	1	1	3	5
	9	0	0	0	1	1	2
	10	0	0	1	0	0	1
	11	0	1	1	0	2	4
Total		15	57	84	31	63	250

APPENDIX B7

Total Available Specimen Questions per Consultation

Descriptives

Disposition				Statistic	Std. Error
Total Available Specimen Questions per Consultation	Emergency	Mean		14.60	1.473
		95% Confidence Interval for Mean	Lower Bound	11.44	
			Upper Bound	17.76	
		5% Trimmed Mean		14.78	
		Median		16.00	
		Variance		32.543	
		Std. Deviation		5.705	
		Minimum		5	
		Maximum		21	
		Range		16	
		Interquartile Range		12.00	
		Skewness		-.828	.580
		Kurtosis		-.878	1.121
	GP 2 Hours	Mean		20.44	.603
		95% Confidence Interval for Mean	Lower Bound	19.23	
			Upper Bound	21.65	
		5% Trimmed Mean		20.13	
		Median		20.00	
		Variance		20.715	
		Std. Deviation		4.551	
		Minimum		12	
		Maximum		42	
		Range		30	
		Interquartile Range		3.50	
		Skewness		2.015	.316
		Kurtosis		8.525	.623
	GP Same Day	Mean		23.71	.908
		95% Confidence Interval for Mean	Lower Bound	21.91	
			Upper Bound	25.52	
		5% Trimmed Mean		23.28	
		Median		20.00	
		Variance		69.315	
		Std. Deviation		8.326	
		Minimum		11	
		Maximum		45	
		Range		34	
		Interquartile Range		10.00	
		Skewness		.992	.263
		Kurtosis		-.198	.520

APPENDIX B7 (continued)

Total Available Specimen Questions per Consultation

Descriptives

GP Routine or Health Profesional	Mean		26.23	1.701
	95% Confidence Interval for Mean	Lower Bound	22.75	
		Upper Bound	29.70	
	5% Trimmed Mean		26.06	
	Median		23.00	
	Variance		89.647	
	Std. Deviation		9.468	
	Minimum		12	
	Maximum		43	
	Range		31	
	Interquartile Range		17.00	
	Skewness		.495	.421
	Kurtosis		-1.113	.821
Home Care	Mean		36.70	.982
	95% Confidence Interval for Mean	Lower Bound	34.74	
		Upper Bound	38.66	
	5% Trimmed Mean		37.22	
	Median		38.00	
	Variance		60.762	
	Std. Deviation		7.795	
	Minimum		18	
	Maximum		46	
	Range		28	
	Interquartile Range		7.00	
	Skewness		-1.284	.302
	Kurtosis		.837	.595

APPENDIX B8

Correlations – CCA- Specimen Questions with Total Available Specimen Questions

Spearman's rho			CCA- Specimen Questions	Total Available Specimen Questions
	CCA- Specimen Questions per Consultation	Correlation Coefficient	1.000	.307(**)
		Sig. (2-tailed)	.	.000
		N	250	250
	Total Available Specimen Questions per Consultation	Correlation Coefficient	.307(**)	1.000
		Sig. (2-tailed)	.000	.
		N	250	250

** Correlation is significant at the 0.01 level (2-tailed).

APPENDIX B8

(continued)

Total Available Specimen Questions * CCA- Specimen Questions Cross-tabulation														
Count		CCA- Specimen Questions												Total
		0	1	2	3	4	5	6	7	8	9	10	11	
Total Available Specimen Questions	5	2	0	0	0	0	0	0	0	0	0	0	0	2
	7	2	0	0	0	0	0	0	0	0	0	0	0	2
	11	1	0	0	0	0	0	0	0	0	0	0	0	1
	12	0	0	1	1	0	0	0	0	0	0	0	0	2
	13	2	0	0	0	0	0	0	0	0	0	0	0	2
	14	2	1	0	1	0	0	0	0	1	0	0	0	5
	15	1	3	1	0	0	0	0	0	0	0	0	0	5
	16	2	1	0	2	1	0	0	0	0	0	0	0	6
	17	4	5	3	4	0	0	0	0	0	0	0	0	16
	18	12	8	4	4	0	1	0	0	0	0	0	0	29
	19	7	5	3	2	1	0	1	0	0	0	0	0	19
	20	7	4	2	1	0	3	0	0	0	0	0	0	17
	21	4	10	4	3	1	0	0	0	0	0	0	0	22
	22	0	0	1	1	0	0	0	0	0	0	0	0	2
	23	4	2	0	1	0	1	0	0	0	0	0	1	9
	24	3	1	2	0	2	1	0	0	0	0	0	0	9
	25	1	0	0	0	0	0	0	0	0	0	0	0	1
	26	3	1	3	1	0	0	0	0	0	0	0	0	8
	27	2	0	1	0	0	1	0	0	0	0	0	0	4
	28	0	0	1	0	2	0	0	0	0	0	0	0	3
	29	0	0	0	0	0	1	0	0	1	0	0	0	2
	30	1	0	0	0	0	1	0	0	0	0	0	0	2
	31	0	0	0	0	0	0	1	0	0	0	0	0	1
	32	1	1	0	0	0	0	0	1	1	0	0	0	4
	33	1	1	0	0	0	0	0	0	0	0	0	0	2
	34	1	0	1	0	0	0	0	0	0	0	0	1	3
	35	0	4	0	0	0	0	0	0	0	1	0	0	5
	36	0	2	0	0	0	0	0	0	0	0	0	0	2
	37	0	2	0	1	0	2	3	0	0	0	0	0	8
	38	2	2	0	5	3	2	1	0	0	0	0	0	15
	39	0	0	0	0	0	1	0	1	0	0	0	0	2
	40	1	2	1	1	0	0	1	0	0	0	1	2	9
	41	2	0	1	1	0	0	1	0	2	1	0	0	8
	42	0	2	0	2	2	2	0	0	0	0	0	0	8
	43	0	1	1	1	2	1	0	0	0	0	0	0	6
	44	0	0	0	0	0	0	1	0	0	0	0	0	1
	45	3	0	0	0	0	0	0	1	0	0	0	0	4
	46	4	0	0	0	0	0	0	0	0	0	0	0	4
Total		75	58	30	32	14	17	9	3	5	2	1	4	250

APPENDIX B9

Descriptive Statistics

CCA- Specimen Questions – Abdominal Pain Algorithm

N	Valid	129
	Missing	0
Mean		1.42
Std. Error of Mean		.144
Median		1.00
Mode		0
Std. Deviation		1.638
Variance		2.683
Skewness		1.566
Std. Error of Skewness		.213
Kurtosis		2.990
Std. Error of Kurtosis		.423
Range		8
Minimum		0
Maximum		8
Percentiles	25	.00
	50	1.00
	75	2.00

CCA- Specimen Questions – Abdominal Pain Algorithm

CCA- Specimen Questions Per Consultation		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	48	37.2	37.2	37.2
	1	33	25.6	25.6	62.8
	2	21	16.3	16.3	79.1
	3	15	11.6	11.6	90.7
	4	3	2.3	2.3	93.0
	5	7	5.4	5.4	98.4
	8	2	1.6	1.6	100.0
	Total	129	100.0	100.0	

APPENDIX B10

Total Available Specimen Questions * CCA- Specimen Questions Cross-tabulation (Abdominal Pain Algorithm)									
Count		CCA- Specimen Questions							Total
		0	1	2	3	4	5	8	
Total Available Specimen Questions	11	1	0	0	0	0	0	0	1
	12	0	0	1	1	0	0	0	2
	13	2	0	0	0	0	0	0	2
	14	2	1	0	1	0	0	1	5
	15	1	3	1	0	0	0	0	5
	16	2	1	0	2	1	0	0	6
	17	3	5	3	2	0	0	0	13
	18	9	5	4	4	0	1	0	23
	19	7	4	3	2	1	0	0	17
	20	5	4	2	0	0	2	0	13
	21	4	7	2	3	1	0	0	17
	22	0	0	1	0	0	0	0	1
	23	4	1	0	0	0	1	0	6
	24	1	1	0	0	0	0	0	2
	25	1	0	0	0	0	0	0	1
	26	2	0	2	0	0	0	0	4
	27	1	0	1	0	0	1	0	3
	28	0	0	1	0	0	0	0	1
	29	0	0	0	0	0	1	1	2
	30	1	0	0	0	0	1	0	2
	33	1	1	0	0	0	0	0	2
	34	1	0	0	0	0	0	0	1
Total		48	33	21	15	3	7	2	129

APPENDIX B11

	CCA- Specimen Questions in the order they occurred in the Consultation - Abdominal Pain							
Case#	CCA-1	CCA-2	CCA-3	CCA-4	CCA-5	CCA-6	CCA-7	CCA-8
2	2a							
6	1.1a	8.3						
8	8.3							
9	8.3							
10	1.1a	2a	8.3					
11								
12	2a							
13								
14								
15	1.2a	1.2b	9					
16	1.2a							
18	3	9						
20								
21	4.1	4.2						
24								
25	1.2b							
26								
28	7.1							
30								
33	3	8.3						
36								
39	2a	8.2	8.3					
42								
43	1.1b	8.1	8.3	10				
45	1.2a	8.2	8.3					
49								
50	5	12						
52								
53	1.2a							
54	1.1a							
55	2a							
56	1.1a	40.1	40.2					
58	1.1b	8.2	8.3					
59	1.2b	53						
62								

APPENDIX B11 (continued)

CCA- Specimen Questions in the order they occurred in the Consultation - Abdominal Pain

Case#	CCA-1	CCA-2	CCA-3	CCA-4	CCA-5	CCA-6	CCA-7	CCA-8
64								
66	8.3							
68	1.1a	8.2						
71								
72	1.1b	8.2	8.3					
73	1.1a	8.2	8.3					
77	1.1a	21.1	21.2	21.3	39			
79	1.2a	3	43	44	49			
80								
81	1.1c	2a						
83	2a							
86	1.1a	8.3						
88								
89								
90	1.1b							
92	8.2	8.3						
93	5	35.3	35.4	38.1	38.2			
99	8.3							
104								
105								
108								
109								
110	15.3							
114	2b	4.1	4.2					
117	1.2a	8.2						
120								
122	8.2							
128								
129	42							
130	1.1b	8.3						
133								
135								
137	8.2	8.3						
138	1.2a	8.2	8.3					
140	1.2a	8.3						
141	12	15.3						
142	7.1	8.3						
145								
146	8.3							

APPENDIX B11 (continued)

CCA- Specimen Questions in the order they occurred in the Consultation - Abdominal Pain

Case#	CCA-1	CCA-2	CCA-3	CCA-4	CCA-5	CCA-6	CCA-7	CCA-8
148								
156								
159	8.3							
161	1.1a	8.1	8.2	8.3	10			
163	1.2a							
166	1.2a	2a	14.1	18	19			
167	2a							
168								
169	1.1a	8.1	8.2	8.3				
170	2a	4.1	4.2	41.1	41.2	51.1	51.2	53
172	4.1	4.2	4.3					
175	10							
177	1.2a							
180								
183	1.2a	4.1	4.2	4.3	7.1	8.1	8.2	8.3
184	9							
186	22.2							
192								
193								
194	1.2a	8.3	10					
195	8.2	8.3						
196								
199	8.2	8.3						
200								
201								
204								
205								
209								
210								
211								
212								
214								
215								
216	1.1a	3						
217	3	4.1	4.2	4.3	9			
218								

APPENDIX B11 (continued)

CCA- Specimen Questions in the order they occurred in the Consultation - Abdominal Pain

Case#	CCA-1	CCA-2	CCA-3	CCA-4	CCA-5	CCA-6	CCA-7	CCA-8
222	1.2a	8.3						
223								
225	8.1	8.2	8.3					
227	2a	8.2	8.3	9				
228	8.1	8.2	8.3					
230	8.3							
231								
232								
234	7.1							
236	8.3							
237	1.2a	8.3						
238	8.3							
240	1.2b							
243	1.2a	3	35.4	38.1	38.2			
244	1.2a							
246	1.1a							
247	1.2a							
248	42	53						
250								

APPENDIX B12

Topics in red are topics which are located at more than one place in the algorithm and are shown here in order to fully represent the Algorithm

NHS CAS Specimen Questions Coding - Abdominal Pain

Topic 1 [Possible Abdominal Aortic Aneurysm

11 (a) Pain began abruptly with a

(b) tearing, searing or ripping excruciating pain

(c) deep along the backbone:

1.2 (a) One or both legs gone completely dead,

(b) pale in colour or lacking in feeling.

Topic 2 [Symptoms of Shock]

2 (a) Cool and clammy skin:

(b) Fainting or passing out.

Topic 3 [History of Chest Pain]

3 Does the individual have chest pain with their symptoms?

Topic 4 [Abdominal Trauma]

4 Does the individual have a history of any of the following:

4.1 Injury caused by a blow or blunt object.

4.2 Injured the area from a significant fall.

4.3 Injury caused by being crushed.

APPENDIX B12 (continued)

NHS CAS Specimen Questions Coding - Abdominal Pain

Topic 5 [Localised Abdominal Pain

5. Is there pain that seems localised to one area of the stomach?

Topic 6 [Significant Vomiting]

6. Has the individual had

(a) significant

(b) vomiting?

Topic 7 [Gastrointestinal Bleeding]

7 Does the individual have a history of any of the following:

7.1 Passing red or maroon-coloured or black- tar coloured bowel movements:

7.2 Vomiting blood or coffee-ground like material.

Topic 8 [Confusion, Drowsiness]

8. Does the individual have a history of any of the following:

8.1 Any loss of consciousness (passed out):

8.2 Confusion or not knowing where they are or what they are doing:

8.3 Excessive sleepiness or feeling drowsy.

Topic 9 [Fever]

9. Does the individual have a fever (temperature over 38.3Cor 101F) or do they feel hot or shivery.

APPENDIX B12 (continued)

NHS CAS Specimen Questions Coding - Abdominal Pain

Topic 10 [Immune Compromise]

10. Has the individual's doctor (or other health care advisor) recommended early assessment due to an underlying condition, if there are any symptoms of possible infection?

Topic 11 [Pregnancy or Possible Pregnancy]

11. a) Is the individual pregnant or is there a chance of pregnancy or

b) have one or more periods been missed?

Topic 12 [Over 12 wks Pregnant]

12. Is the individual more than 20 weeks/5 months pregnant?

Topic 13 [Labour]

13 Are there strong, regular contractions or cramping pain that does not go away when walking around?

Topic 14 [Gastrointestinal Bleeding]

14 Does the individual have a history of any of the following:

14.1 Passing red or maroon-coloured or black- tar coloured bowel movements:

14.2 Vomiting blood or coffee-ground like material.

Topic 15 [Confusion, Drowsiness]

15. Does the individual have a history of any of the following:

15.1 Any loss of consciousness (passed out):

15.2 Confusion or not knowing where they are or what they are doing: 15.3 Excessive sleepiness or feeling drowsy.

APPENDIX B12 (continued)

NHS CAS Specimen Questions Coding - Abdominal Pain

Topic 16 [Vaginal Bleeding]

16. Is there any bleeding from the vagina?

Topic 17 [Vaginal Discharge]

17. Is there any discharge from the vagina?

Topic 18 [Lower Abdominal Pain]

18. Are there pains in the lower stomach (cramping), lower back or in the pelvis?

Topic 19 [Home Treatment Failure]

19. Have the symptoms remained unchanged or worsened even after trying home treatments?

Topic 20 [Flank Pain, Lower Back Pain]

20. Does the individual have pain

a) in the lower back or below the ribs in the back on

b)one or both sides?

Topic 21 [Upper Abdominal Pain]

21. Is there any of the following;

22.1 Pain in the stomach above the belly button,

22.2 Pain located along the ribs,

22.3 Pain in the stomach located just below the breastbone.

APPENDIX B12 (continued)

NHS CAS Specimen Questions Coding - Abdominal Pain

Topic 22 [Gastrointestinal Bleeding]

22. Does the individual have a history of any of the following:

22.1 Passing red or maroon-coloured or black- tar coloured bowel movements:

22.2 Vomiting blood or coffee-ground like material.

Topic 23 [Abdominal Pain Radiating to the Back]

23 Is the pain in the pit of the stomach or does the pain feel like something is stabbing through from the stomach to the back?

Topic 24 [Significant Vomiting]

24 Has the individual had

(a) significant

(b) vomiting?

Topic 25 [Right Sided Abdominal Pain]

25. Does the stomach pain

a) come in waves

b) starting on the right side below the ribs?

Topic 26 [Fever]

26. Does the individual have a fever (temperature over 38.3Cor 101F) or do they feel hot or shivery.

APPENDIX B12 (continued)

NHS CAS Specimen Questions Coding - Abdominal Pain

Topic 27 [Significant Vomiting]

27 Has the individual had

(a) significant

(b) vomiting?

Topic 28 [Significant Vomiting]

28 Has the individual had

(a) significant

(b) vomiting?

Topic 29 [Vomiting with Alcohol]

29 Did the vomiting start after drinking large amounts of alcoholic beverages?

Topic 30 [Seizure Activity]

30 Has the individual had a seizure, convulsion, fit?

Topic 31 [Alcohol Withdrawal Symptoms]

31 Is the individual

31.1 Confused or seeing objects that are not real (hallucinating:

31.2 Feeling like they're getting the shakes (Delirium Tremens)

APPENDIX B12 (continued)

NHS CAS Specimen Questions Coding - Abdominal Pain

Topic 32 [Possible Food Poisoning]

32 Could the symptoms possibly be due to something the individual ate or have other people become sick with whom the individual shared a meal?

Topic 33 [Recurrent Abdominal Pain]

33. Has the individual been having

a) stomach pains on and off

b) over the past few weeks

Topic 34 [Viral Gastroenteritis]

34. Has the individual

34.1 Flu with general aching in the muscles or joints:

34.2 Mild Headache:

34.3 Nausea or feeling like vomiting:

34.4 Feverish or does the individual have an elevated temperature

Topic 35 [Dyspepsia]

35. Has the individual

36.1 Stomach cramping:

36.2 Discomfort or bloating that comes or goes:

36.3 Frequent burping, belching or hiccups after eating:

36.4 Heartburn between meals

NHS CAS Specimen Questions Coding - Abdominal Pain

Topic 36 [First Episode]

36. Is this the first occurrence of this symptom?

Topic 37 [Self Treatment Failure]

37. Has the individual

37.1 Worsening symptoms over the past 24 hours despite using regular doses of appropriate medications or other physical measures:

37.2 Symptoms remain the same despite regular doses of appropriate medications or other physical measures:

37.3 Symptoms have been relieved by using regular doses of medications or other physical measures:

37.4 No symptom relieving medications or other physical measures have been tried

Topic 38 [Symptoms of Shingles]

38. Does the individual have

38.1 Very uncomfortable burning sensation of the skin in the area when stoked with a light touch:

38.2 Presence of small blisters in clusters surrounded by a red halo in the area of pain

Topic 39 [Lower Abdominal Cramping]

39. Is there stomach cramps or pain in the lower stomach below the belly button?

APPENDIX B12 (continued)

NHS CAS Specimen Questions Coding - Abdominal Pain

Topic 40 [Gastrointestinal Bleeding]

40. Does the individual have a history of any of the following:

40.1 Passing red or maroon-coloured or black- tar coloured bowel movements:

40.2 Vomiting blood or coffee-ground like material.

Topic 41 [Testicular Pain/Swelling]

41. Does the individual have

42.1 Pain or swelling of one or both testicles:

42.2 Swelling, pain and redness of the scrotum?

Topic 42 [Groin Pain/Swelling]

42. Is there pain in the groin area?

Topic 43 [Vaginal Bleeding]

43 Is there any bleeding from the vagina?

Topic 44 [Vaginal Discharge]

44. Is there any discharge from the vagina?

NHS CAS Specimen Questions Coding - Abdominal Pain

Topic 45 [Diarrhoea over 72 Hours]

45. Has there been

a) continuous diarrhoea (4-6 loose, watery stools)

b) for more than 72 hours?

Topic 46 [Recent Travel]

46. Has the individual travelled outside of the United Kingdom in the last few weeks to an area with a known high risk of communicable disease?

Topic 47 [Self Treatment Failure]

47. Has the individual

47.1 Worsening symptoms over the past 24 hours despite using regular doses of appropriate medications or other physical measures:

47.2 Symptoms remain the same despite regular doses of appropriate medications or other physical measures:

47.3 Symptoms have been relieved by using regular doses of medications or other physical measures:

47.4 No symptom relieving medications or other physical measures have been tried.

Topic 48 [Dysuria]

48. Is the individual having pain and burning when they are passing urine?

APPENDIX B12 (continued)

NHS CAS Specimen Questions Coding - Abdominal Pain

Topic 49 [Alternating Constipation/Diarrhoea]

49. Has the individual been having constipation that alternates with diarrhoea?

Topic 50 [Fever]

50. Does the individual have a fever (temperature over 38.3Cor 101F) or do they feel hot or shivery.

Topic 51 [Symptoms of Shingles]

51. Does the individual have

51.1 Very uncomfortable burning sensation of the skin in the area when stoked with a light touch:

51.2 Presence of small blisters in clusters surrounded by a red halo in the area of pain

Topic 52 [Fever]

52. Does the individual have a fever (temperature over 38.3Cor 101F) or do they feel hot or shivery.

Topic 53 [Immune Compromise]

53. Has the individual's doctor (or other health care advisor) recommended early assessment due to an underlying condition, if there are any symptoms of possible infection?

NHS CAS Specimen Questions Coding - Abdominal Pain

Topic 54 [Self Treatment Failure]

54. Has the individual

54.1 Worsening symptoms over the past 24 hours despite using regular doses of appropriate medications or other physical measures:

54.2 Symptoms remain the same despite regular doses of appropriate medications or other physical measures:

54.3 Symptoms have been relieved by using regular doses of medications or other physical measures:

54.4 No symptom relieving medications or other physical measures have been tried.

APPENDIX B13

Statistics

CCA- Specimen Questions – Fever Toddler

N	Valid	121
	Missing	0
Mean		2.97
Std. Error of Mean		.260
Median		2.00
Mode		0
Std. Deviation		2.863
Variance		8.199
Skewness		1.041
Std. Error of Skewness		.220
Kurtosis		.558
Std. Error of Kurtosis		.437
Range		11
Minimum		0
Maximum		11
Percentiles	25	1.00
	50	2.00
	75	5.00

CCA- Specimen Questions – Fever Toddler

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	27	22.3	22.3	22.3
	1	25	20.7	20.7	43.0
	2	9	7.4	7.4	50.4
	3	17	14.0	14.0	64.5
	4	11	9.1	9.1	73.6
	5	10	8.3	8.3	81.8
	6	9	7.4	7.4	89.3
	7	3	2.5	2.5	91.7
	8	3	2.5	2.5	94.2
	9	2	1.7	1.7	95.9
	10	1	.8	.8	96.7
	11	4	3.3	3.3	100.0
	Total	121	100.0	100.0	

APPENDIX B14

Total Available Specimen Questions * CCA- Specimen Questions Cross-tabulation (Abdominal Pain Algorithm)

Count

Total Available Specimen Questions	Total Available Specimen Questions * CCA- Specimen Questions Cross-tabulation (Abdominal Pain Algorithm)												
	0	1	2	3	4	5	6	7	8	9	10	11	Total
5	2	0	0	0	0	0	0	0	0	0	0	0	2
7	2	0	0	0	0	0	0	0	0	0	0	0	2
17	1	0	0	2	0	0	0	0	0	0	0	0	3
18	3	3	0	0	0	0	0	0	0	0	0	0	6
19	0	1	0	0	0	0	1	0	0	0	0	0	2
20	2	0	0	1	0	1	0	0	0	0	0	0	4
21	0	3	2	0	0	0	0	0	0	0	0	0	5
22	0	0	0	1	0	0	0	0	0	0	0	0	1
23	0	1	0	1	0	0	0	0	0	0	0	1	3
24	2	0	2	0	2	1	0	0	0	0	0	0	7
26	1	1	1	1	0	0	0	0	0	0	0	0	4
27	1	0	0	0	0	0	0	0	0	0	0	0	1
28	0	0	0	0	2	0	0	0	0	0	0	0	2
31	0	0	0	0	0	0	1	0	0	0	0	0	1
32	1	1	0	0	0	0	0	1	1	0	0	0	4
34	0	0	1	0	0	0	0	0	0	0	0	1	2
35	0	4	0	0	0	0	0	0	0	1	0	0	5
36	0	2	0	0	0	0	0	0	0	0	0	0	2
37	0	2	0	1	0	2	3	0	0	0	0	0	8
38	2	2	0	5	3	2	1	0	0	0	0	0	15
39	0	0	0	0	0	1	0	1	0	0	0	0	2
40	1	2	1	1	0	0	1	0	0	0	1	2	9
41	2	0	1	1	0	0	1	0	2	1	0	0	8
42	0	2	0	2	2	2	0	0	0	0	0	0	8
43	0	1	1	1	2	1	0	0	0	0	0	0	6
44	0	0	0	0	0	0	1	0	0	0	0	0	1
45	3	0	0	0	0	0	0	1	0	0	0	0	4
46	4	0	0	0	0	0	0	0	0	0	0	0	4
Total	27	25	9	17	11	10	9	3	3	2	1	4	121

APPENDIX B15

CCA- Specimen Questions in the order the occurred in the Consultation

Fever Toddler Algorithm

	CCA- Specimen Questions in the order they occurred in the Consultation - Fever Toddler										
Case#	CCA -1	CCA -2	CCA -3	CCA -4	CCA -5	CCA -6	CCA -7	CCA -8	CCA -9	CCA-10	CCA-11
1	1.2	4.3	7.4	8.3	8.4						
3	1.2	4.2	4.4	6	22.1	22.2					
4	4.3	4.4	6								
5											
7	1.2	4.1									
17	11	31	32	33	45	47	49	50	54		
19	4.1										
22	7.3	7.4	50								
23	1.2	4.1	4.3	4.4	7.3	7.4	8.4				
27											
29	6	7.5	10	54							
31	1.2	1.3	4.2	4.3	4.4	7.2	7.3	7.4	7.5	8.4	11
32	4.1	4.2	4.3	4.4	9	14					
34	1.2	4.2	4.3	4.4							
35	4.5	9	10								
37											
38	1.5	4.3									
40	4.1	4.2	4.3	4.4							
41											
44	1.2	4.2	4.3	4.4							
46	4.1	4.2	4.3	4.4							
47											
48											
51	4.1	4.2	4.3	4.4	7.4	8.4	11	14	45		
57											
60	4.3	4.4	6	9							
61	1.2	4.2	4.3	4.4							
63	4.4										
65	11										
67	7.3	7.4	10								
69	1.2	1.3	4.1	4.2	4.3	4.4	31	52			
70	9	10	48	49	53						
74	7.2										
75	4.2	4.3	9								

APPENDIX B15 (continued)

CCA- Specimen Questions in the order the occurred in the Consultation

Fever Toddler Algorithm

Case #	CCA -1	CCA -2	CCA -3	CCA -4	CCA -5	CCA -6	CCA -7	CCA -8	CCA -9	CCA -10	CCA-11
76	4.2	4.3	4.4								
78	1.2										
82											
84	1.2	4.1									
85	1.2	4.4	7.2								
87											
91	7.3	7.4	10								
94	4.3	10	11								
95	4.3										
96	1.2	11									
97	1.2	4.3	4.4	6	7.1	7.3	7.4	7.5	10	13	50
98	1.2	4.2	4.3	4.4							
100	2.1	7.5	9	11	32	33					
101	1.2	2.1	4.2	4.3	4.4						
102	1.2	4.2	4.3	4.4	10	49					
103	49										
106											
107	1.2	1.5	4.4								
111											
112	1.2	4.1	7.4	11	45					49	
113	1.2										
115	4.3	7.5									
116											
118	4.1	4.2	11	19	21	22.1	22.3				
119	2.2										
121											
123											
124	4.3										
125	4.4										
126											
127											
131	4.1	4.3	4.4								
132	4.1	4.2	4.3	4.4							
134	4.2	4.3	4.4								
136	8.3										

APPENDIX B15 (continued)

CCA- Specimen Questions in the order the occurred in the Consultation

Fever Toddler Algorithm

Case #	CCA -1	CCA -2	CCA -3	CCA -4	CCA -5	CCA -6	CCA -7	CCA -8	CCA -9	CCA -10	CCA-11
139											
143	4.3	4.4									
144	1.2	4.3	9	11	13	53					
147	1.2										
149	1.2	4.4	7.2								
150	3										
151	1.2	1.5	4.1	4.2	4.4	7.1	7.2	7.3	8.2	8.3	8.4
152	1.2	8.3									
153	1.5	4.3									
154											
55	4.3	4.4	6	9							
157	4.3										
158	49										
160	1.2										
162	1.2										
164	1.2	4.3	4.4	6	7.1	7.3	7.4	7.5	13	50	
165											
171											
173											
174	4.3	4.4	7.1	7.2	7.3	7.4					
176	1.2	1.5	4.2	4.4	7.3	7.4	7.5	8.3	8.4	10	16
178											
179	4.3										
181											
182	1.2	4.3									
185	4.1	4.2	4.3	4.4	14						
187	9	10	44	46	48	49	53				
188	1.2	2.1	4.1	4.2	4.3	4.4					
189	11	31	32	33	45	47	50	54			
190	1.2	4.3	4.4								
191	1.2	1.5	7.4								
197											
198	4.1	4.2	4.3	7.3	7.4						
202	4.4										
203	4.3	4.4	7.5								

APPENDIX B15 (continued)

CCA- Specimen Questions in the order the occurred in the Consultation

Fever Toddler Algorithm

Case#	CCA -1	CCA -2	CCA -3	CCA -4	CCA -5	CCA -6	CCA -7	CCA -8	CCA -9	CCA-10	CCA-11
206	1.2										
207	4.1	4.2	4.3	4.4	6	9					
208	2.1	7.5	9	32	33						
213	44										
219											
220	4.1	4.2	4.3	4.4	7.3						
221	4.3										
224	6	7.4	18	22.1	22.2						
226											
229	1.1	1.2	1.3	4.2	4.3	4.4	8.4	10			
233	4.3	4.4	10	17							
235	4.1	7.3	10	11	45						
239	4.4	7.4	7.5								
241											
242	9	10	16	32	44	46					
245	2.2										
249	4.1										

APPENDIX B16

NHS CAS Specimen Questions Coding Fever Toddler

Topics in red are topics which are located at more than one place in the algorithm and are shown here in order to fully represent the Algorithm

Topic 1 [Infant Respiratory Distress]

1. Does the individual have any of the following;

    1.1 Gasping Breaths:

    1.2 Extreme Pallor:

    1.3 Grunting noises with each breath:

    1.4 Irregular breathing with pauses:

    1.5 Turning bluish or pale around the lips or fingernails

Topic 2 [Gravely Ill Child]

2. Is the individual;

    2.1 Completely floppy without muscle tone:

    2.2 Unresponsive to the care giver or cannot be roused

Topic 3 [Child Petechial or Haemorrhagic Rash]

3. Does the child have a rash with purple spots or bleeding into the skin and do they remain when a glass is rolled over them?

Topic 4 [Child Meningeal Symptoms]

4. Does the individual have any of the following;

    4.1 Not able to touch chin to chest:

    4.2 Distress or severe eye pain with exposure to light:

    4.3 Intense headache:

    4.4 Mental confusion, or difficult to rouse

APPENDIX B16 (continued)

NHS CAS Specimen Questions Coding Fever Toddler

Topic 5 [Toddler Bilious Vomiting]

5. Has there been any bile stained vomiting (green colour, not yellow)?

Topic 6 [Toddler Bloody Stools]

6. Has there been any frank blood (not streaks) mixed with the toddler's stools or in the nappy?

Topic 7 [Toddler Cortical Neurological Symptoms]

7. Does the individual have any of the following;

7.1 Sleepy or difficult to awaken compared to usual:

7.2 More floppy (limp) than normal for him/her:

7.3 Crying differently to normal, e.g. persistent weak, moaning, high pitched cry:

7.4 a) Irritable for over 4 hours,

b)not calm when held, rocked or cuddled:

7.5 Responds less to what is going on around him/her

Topic 8 [Toddler Risk of Dehydration]

8. Does the individual have any of the following;

8.1 Has vomited persistently during the last 8-12 hours:

8.2 Has had more than 8 episodes of diarrhoea during the last 8-12 hours:

8.3 Has refused to drink there usual fluids during the last 8-12 hours:

8.4 Has not passed any urine during the passed 8-12 hours.

APPENDIX B16 (continued)

NHS CAS Specimen Questions Coding Fever Toddler

Topic 9 [Child Groin Swelling]

9. Does the child have a swelling or lump on either side of the groin?

Topic 10 [Care Giver Intuition]

10. Does the carer think that the child looks especially ill or sicker than with other illnesses?

Topic 11 [Child Immune Compromise]

11. Has their doctor (or other health adviser) recommended early assessment of the child due to an underlying condition, if there are symptoms of possible infection?

Topic 12 [Toddler Vomiting]

12. Has the toddler been vomiting?

Topic 13 [Child Testicular/Groin Swelling

13. Are one or both of the child's testicles painful or swollen?

Topic 14 [Toddler Watery Stools]

14. Has the toddler been passing watery stools every hour for the past 6 hours?

Topic 15 [Child Abdominal Pain]

15. Is the individual

    15.1 Holding stomach:

    15.2 Rubbing or complaining of stomach ache:

    15.3 Guarding stomach

APPENDIX B16 (continued)

NHS CAS Specimen Questions Coding Fever Toddler

Topic 16 [Not Tolerating Oral Fluids]

16. Is the individual unable to drink fluids and keep them down (YES = NOT ABLE TO TAKE FLUIDS AND KEEP THEM DOWN, NO = ABLE TO TAKE FLUIDS AND KEEP THEM DOWN)?

Topic 17 [Child Crying or in Pain]

17. Is the individual crying and seems to be in pain?

Topic 18 [Child Abdominal Pain]

18. Is the individual

18.1 Holding stomach:

18.2 Rubbing or complaining of stomach ache:

18.3 Guarding stomach

Topic 19 [Toddler Recent Surgery]

19. Has the toddler had any surgery within the past 10 days?

Topic 20 [Toddler Earache or Ear Pain]

20. Is the toddler

a) pulling on an ear or

b) complaining of an earache?

APPENDIX B16 (continued)

NHS CAS Specimen Questions Coding Fever Toddler

Topic 21 [Toddler Localised Limb Pain]

21. Does the toddler seem to be having pain localised to one of his or her limbs (arm or leg)?

Topic 22 [Toddler Symptoms of Skin Infection]

22. Does the individual have any of the following;

22.1 Localised redness, increased warmth to touch, swelling, & tenderness to touch of skin or involved area:

22.2 Red streaks moving away from the affected area.

Topic 23 [Toddler Recent Vaccination]

23. Has the toddler;

a) had any injections

b) in the past 10 days?

Topic 24 [Active Care Fever Reduction]

24. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

NHS CAS Specimen Questions Coding Fever Toddler

Topic 25 [Infant Not Tolerating Fluids]

25. Is the individual unable to drink fluids and keep them down (YES = NOT ABLE TO TAKE FLUIDS AND KEEP THEM DOWN, NO = ABLE TO TAKE FLUIDS AND KEEP THEM DOWN)?

Topic 26 [Active Care Fever Reduction]

26. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

Topic 27 [Active Care Fever Reduction]

27. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

Topic 28 [Infant Not Tolerating Fluids]

28. Is the individual unable to drink fluids and keep them down (YES = NOT ABLE TO TAKE FLUIDS AND KEEP THEM DOWN, NO = ABLE TO TAKE FLUIDS AND KEEP THEM DOWN)?

APPENDIX B16 (continued)

NHS CAS Specimen Questions Coding Fever Toddler

Topic 29 [Active Care Fever Reduction]

29. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

Topic 29 [Active Care Fever Reduction]

30. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

Topic 31 [Toddler Rash]

31. Does the toddler have a rash?

Topic 32 [Toddler Earache or Ear Pain]

32. Is the toddler

a) pulling on an ear or

b) complaining of an earache?

NHS CAS Specimen Questions Coding Fever Toddler

Topic 33 [Recent Travel]

33. Has the individual travelled outside of the United Kingdom in the last few weeks to an area with a known high risk of communicable disease?

Topic 34 [Severe Foreign Travel Symptoms]

34. Does the individual have any of the following;

34.1 Bloody diarrhoea:

34.2 Vomiting:

34.3 Shortness of breath:

34.4 Pain when passing urine

Topic 35 [Toddler Recent Surgery]

35. Has the toddler had any surgery within the past 10 days?

Topic 36 [Active Care Fever Reduction]

36. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

Topic 37 [Recent Vaccinations]

37. Has the toddler;

a) had any injections

b) in the past 10 days?

APPENDIX B16 (continued)

NHS CAS Specimen Questions Coding Fever Toddler

Topic 38 [Active Care Fever Reduction]

38. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

Topic 39 [Child Shaking Chills]

39. Is the child having bouts of uncontrollable shaking or shivering?

Topic 40 [Teething Toddler]

40 Is the toddler teething?

Topic 41 [Active Care Fever Reduction]

41. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

Topic 42 [Fever Over 5 Days Duration]

42. Has the individual's fever been present on and off for more than 5 days?

APPENDIX B16 (continued)

NHS CAS Specimen Questions Coding Fever Toddler

Topic 43 [Active Care Fever Reduction]

43. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

Topic 44 [Toddler Dressed too Warmly]

44. Could the toddler have too many layers of clothes on or covered with too many blankets?

Topic 45 [Toddler Recent Surgery]

45. Has the toddler had any surgery within the past 10 days?

Topic 46 [Active Care Fever Reduction]

46. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

Topic 47 [Recent Vaccinations]

47. Has the toddler;

a) had any injections

b) in the past 10 days?

APPENDIX B16 (continued)

NHS CAS Specimen Questions Coding Fever Toddler

Topic 48 [Active Care Fever Reduction]

48. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

Topic 49 [Child Shaking Chills]

49. Is the child having bouts of uncontrollable shaking or shivering?

Topic 50 [Teething Toddler]

50. Is the toddler teething?

Topic 51 [Active Care Fever Reduction]

51. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

Topic 52 [Fever Over 5 Days Duration]

52. Has the individual's fever been present on and off for more than 5 days?

APPENDIX B16 (continued)

NHS CAS Specimen Questions Coding Fever Toddler

Topic 53 [Active Care Fever Reduction]

53. Does the following apply;

a) Have medications or appropriate physical measures been tried to reduce the fever and

b) has the temperature remained high despite these measures (YES=TRIED MEASURES AND NOT WORKING, NO=Not tried to reduce the fever OR fever is reduced)?

Topic 54 [Toddler Dressed too Warmly]

54. Could the toddler have too many layers of clothes on or covered with too many blankets?